AUGUST, 1953

PETROLEUM REFINER

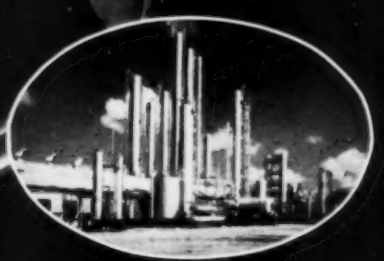
Specialized for Refining, Natural Gasoline, Petrochemical Engineering, Operations and Management.

For a **Quick Look** at this issue see page 2

THE GREATEST NAME IN

Blending

WARREN NATURAL



NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE
NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
STA-VOL-ENE

WARREN
PETROLEUM CORPORATION
TULSA, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren
EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARREN, HOUSTON, TEXAS

IT FLOATS ON THE LOAD!*

You turn on the steam.

This little stainless steel valve—the only moving part in the Yarway Impulse Steam Trap installed on the equipment—opens wide and *stays* open as the air and condensate continuously pour through.

The equipment reaches production temperature in the quickest possible time.

Production temperature reached, the little valve snaps shut. After that, by a pulsating action, it discharges all condensate as it forms—even a tiny teaspoonful. *There's hot steam in the equipment all the time . . .* steady, maximum temperatures are maintained.

It all adds up—to more production per day.

Other profit-making features of the Yarway Impulse Steam Trap—low initial cost, easy installation, stainless steel construction, low maintenance, good for all pressures, quick delivery from over 200 local industrial distributors.

Try a Yarway—free for 60 days—and *prove* its advantage. Your distributor will supply you.

For free Yarway Impulse Steam Trap Bulletin T-1740, write . . .

YARNALL-WARING COMPANY
128 Mermaid Ave., Philadelphia 18, Pa.

*. . . *resulting in fast heat-up of equipment, more production per day.*

YARWAY | *impulse steam trap*

Volume 32, No. 8 August, 1953

PETROLEUM REFINER

Specialized Oil Engineering Magazine Covering Refinery, Natural Gasoline, Petrochemical Engineering, Operation and Maintenance

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for the refining-natural gasoline-petrochemical industry

WORLD OIL (formerly The Oil Weekly)
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for the drilling-producing-pipe line industry

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D. S. CRAIG, Mgr. Advertising Service Dept.

Circulation Department
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Box 2608, Houston, Texas

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A Quick Look at Petroleum Refiner this month

Liquid Fuels in America . . . Here is a long-range analysis, penetratingly thoughtful. In definite terms the author spells out the adequacy of petroleum and gives a time-table for residual fuel oil conversion, oil from shale, and coal hydrogenation. **Page 90.**

An Economic Comparison of Electric Motors vs. Steam Turbines for FCCU . . . A fluid catalytic cracking unit requires a tremendous amount of power with a high degree of continuity. This paper is a perceptive analysis of the investment cost, operating cost, flexibility of operation, and operating record of steam turbine and electric motor drives. No philosopher, the author relies on cold dollars-and-cents figures to present his comparison. A careful study of this article may result in savings of as much as $\frac{1}{2}$ million for you. It's worth your time. **Page 96.**

Thermodynamic Data for Low Temperature Design? . . . Remember the last time you designed a low temperature plant or process? You can recall the lack of reliable correlated data. The fluids behave much differently from those at atmospheric temperatures. The properties of mixtures are sensitive even to slight changes in pressure and composition. This is because the conditions of pressure are closer to the convergence or critical pressure of the mixture. The cost of refrigeration is high and the use of a design safety factor, because of a lack of accurate data, may result in prohibitive costs. The authors present the sources of the available low-temperature data and tell how to use correlated data correctly. **Page 101.**

Approximating Natural Gas Composition . . . A chart has been developed which predicts the hydrocarbon composition of natural gas when the specific gravity and adsorption index of the gas are known. In the testing of 34 natural gases of widely differing compositions, it was determined that this means of estimation was accurate to about plus or minus 10 percent for individual components and to about plus or minus 5 percent for groups of components. **Page 105.**

LTFD Calculation Procedures . . . Although differences in analytical results between laboratories are usually due to errors in technique, variations in calculation procedures have contributed to the discrepancies. This article presents precise calculation procedures with the understanding that although routine analyses may not justify the various refinements, a better knowledge of their existence may promote better analytical results. **Page 109.**

Save LTFD Calculation Time With These Sheets . . . Illustrated calculation sheets relieve chemists of the routine task of calculating low temperature distillation analyses. In addition, the calculations can be made more accurately and rapidly. Further, the training period of new operators can be shortened because lengthy calculation instructions can be eliminated. **Page 115.**

New Flowmeter Measures True Mass Rate . . . Here is a new flowmeter which measures the true mass rate of flow independent of any physical properties of the flowing fluid. The meter can be calibrated without passing fluid through it, has an exceptional high speed of response, and can measure an accurate average for pulsating flows. Here you will find discussed an experimental model, the flowmeter performance and current development, as well as the principle of this new flowmeter. **Page 119.**

Understanding the Chemistry of Petrochemical Reactions . . . Part 4 of this primer of petrochemicals covers the oxidation reactions of hydrocarbons. The large tonnage petrochemicals, such as alcohols, aldehydes, ketones, and acids, are produced mostly by these reactions. Liquid phase oxidation of paraffin wax is becoming a big business. The oxidation of cumene, benzene, toluene and other aromatics is discussed. **Page 127.**

Electrical Problems in Petrochemical Process Control . . . Precise control of process variables is absolutely necessary for maximum production of top quality products. The author discusses the problems associated with the newest types of control instruments and offers valuable suggestions on such matters as fast-acting controls, explosion-proofing, maintenance and frequency response techniques. Here is high interest reading for all refinery and petrochemical men. **Page 127.**

Casebook of a Corrosion Chemist . . . Five tough corrosion problems and their solutions are presented by this veteran corrosion chemist. Condensed for quick and easy reading, this short feature may provide the answers you've been seeking for corrosion in reboilers, condenser tube sheets, etc. Turn to **page 131.**

The Design and Construction of Control Valves. What makes the wheels go round in refineries and petrochemical plants? Why, the control valves, of course. Read this authoritative discussion of how they are constructed, materials of construction, and the effect of design on operation. There is a world of information packed into this two-page paper. **Page 133.**

Refining With Adsorbents—Part III . . . Percolation is the most widely used process for applying adsorbents to the oil. This, the third part of a series, details the application of fuller's earth and bauxite in this method. Of special importance is the discussion of the latest techniques for regenerating adsorbents without loss of decolonizing properties. **Page 135.**

Determining Tetraethyl Lead in Gasoline by Flame Photometry . . . Photometric methods are accurate and fast, though the original cost of the equipment is much lower. Here is the analytical procedure and also the relative accuracy compared with the chemical methods. **Page 139.**

Take Another Look at Economic Pipe Sizing . . . As a solution to the lamentable oversimplification in pipe sizing, this author presents a new method and a new philosophy to the estimation of piping costs in selecting process line size. By this rapid method, the engineer can ferret out those particular lines which require more detailed study. **Page 141.**

How Much Authority Should Safety Directors Have? Very little, they replied in answer to a PETROLEUM REFINER questionnaire. Should they have authority to penalize a worker for persistent infractions of the safety rules? To recommend punishment? To shut down an installation? For some outspoken opinions on these and other controversial questions, turn to **page 187.**

The Foreman, the Worker, and Human Relations . . . No longer are the foreman's functions limited to carrying out policy and maintaining production schedules. Far more important these days is the ability to lead men. Here is a thought-provoking article that will benefit every supervisor. **Page 190.**

Will Refinery Wastes Kill Fish? . . . Certainly. These wastes can deal a lethal blow to marine life and arouse the indignation of sportsmen. The current government interest in the problem has been aroused to a great extent by fishermen. There is a definite problem. The logical process is to define the limits and scope. And from the results determine the solution. Here's a report on the original research to determine just how fish are killed by wastes, the toxic concentration levels, and methods of reducing toxicity of wastes. **Page 145.**

PROCESS ISSUE Next Month

A preview of next month's PROCESS ISSUE finds these new developments up for publication. Don't miss this opportunity to see the best picture of processing in the industry, for the year 1953. In the September issue you will read about . . .

New Processes

Cyclic Adsorption Refining
Alkylation with Effluent Refrigeration
Electric Lube Oil Treating

First Commercial Installations

Atlantic Catalytic Reforming
Electric Distillate Treating
Fuel Oil Desaponification

Symposia on Ammonia and Derivatives

Hydrogen Cyanide
Urea
Methanol

What it takes to make a 3000 Degree Refractory Concrete

Because of the widespread interest in the use of refractory castables, many furnace operators have asked us for the story behind the performance of B&W's unique refractory concrete, Kaocast.

Here are the answers to some of the most frequently asked questions:

Q. *When you refer to Kaocast as a 3000 degree refractory castable, do you mean that its melting point is 3000° F?*

A. No, this means that its service use limit is 3000° F; its melting point is 200 degrees higher.

Q. *Just what does it take to make a 3000 degree refractory castable like B&W Kaocast?*

A. Let's first define a few terms. Refractory castables are made with granular materials which are volume stable at high temperatures and which can undergo repeated heating and cooling cycles without disintegration. These materials, known as refractory calcines or grogs, are blended with suitable hydraulic binders. The initial strength of a refractory castable is thus developed in the same manner as that of ordinary concrete—that is, through the chemical action between water and the binder. A strong *ceramic bond* is formed when the refractory castable is subjected to temperatures above the vitrification point.

Q. *Then you have a grog, a binder and a method of putting them together. Which is most important?*

A. You can't say that any *one* is most important. It's a combination of all three. Let's take them one at a time. Our grog consists primarily of the proper blend of kaolin and other alumina-silica materials. This ratio enables us to achieve a grog with minimum expansion and shrinkage, a high fusion point, and greater stability under load, at varying temperatures.

Q. *And now, what about the binder?*

A. There are a number of factors responsible for the success of the Kaocast binder. One is the compound Tricalcium Penta-aluminate (3 lime to 5 alumina). This formula produces the most refractory compound (highest melting point) that can be made from lime and alumina. Another is that by using the purest commercially available lime and alumina, the Kaocast binder is substantially free of iron and silica. Such traces of these that are present combine during the pre-firing of the binder to produce stable compounds.

Q. *Just how important is the manufacturing or "blending" of the grog and the binder?*

A. If one factor could be singled out as "most important" it would be quality control.

Direct control over the fineness of materials, prefiring temperatures, and other phases of manufacture is possible at B&W because both the grog and the binder are made and blended at B&W's Augusta Works—under B&W's direct control and supervision.

Q. *These factors you've discussed must add up to some specific advantages of Kaocast. What are they?*

A. B&W Kaocast has all the advantages of easy installation which are responsible for the widespread interest in refractory concretes, plus these exclusive features: It is the only 3000 degree refractory concrete with high resistance to spalling and low volume change throughout its operating range.

THE BABCOCK & WILCOX CO.
Refractories Division
General Offices:
161 East 42nd St., New York 17, N. Y.
Works: Augusta, Ga.

(Advertisement)

Eliminates Auxiliary Equipment with Portable Drilling Rigs

Ro-Flo AIR COMPRESSORS

A new air blast drilling technique developed by the Winter-Weiss Company and adaptable to all their PORTADRILL rigs uses *Ro-Flo* rotary air compressors to eliminate extensive and costly auxiliary equipment in some types of drilling operations.

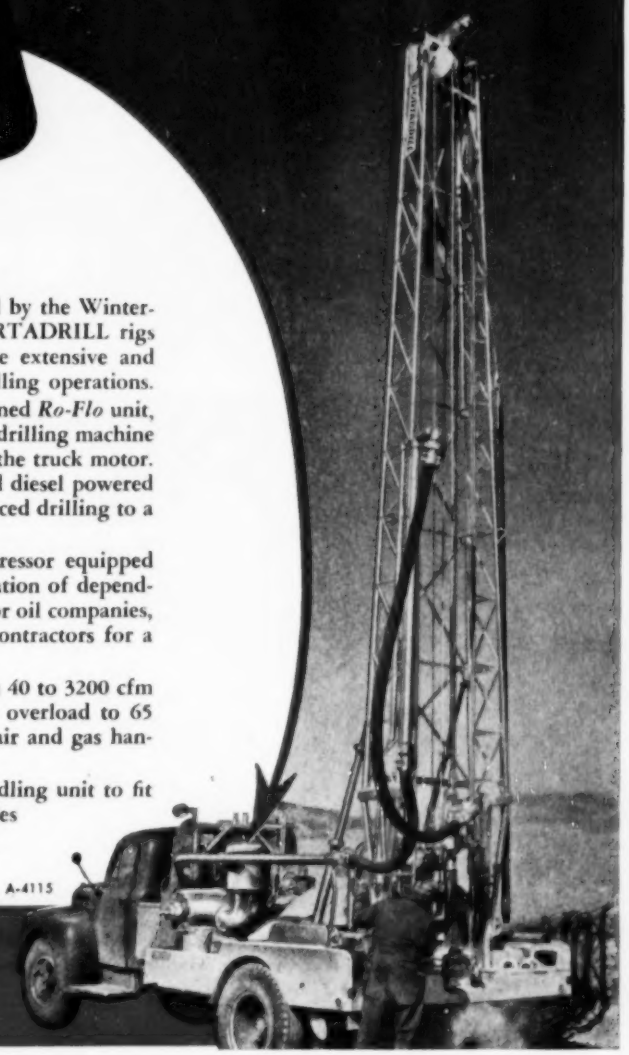
Through the use of the compact and self-contained *Ro-Flo* unit, all apparatus can be integrally mounted with the drilling machine on a single truck chassis. Power is generated by the truck motor. This elimination of a separate truck mounted and diesel powered compressor has minimized drilling costs and reduced drilling to a one unit operation.

Field expeditions with the new *Ro-Flo* compressor equipped PORTADRILL rig quickly earned for it a reputation of dependability. It has been chosen for exploration by major oil companies, geophysical organizations, and by independent contractors for a multitude of uses.

Ro-Flo compressors are built in capacities from 40 to 3200 cfm at pressures from 5 to 40 psig with momentary overload to 65 psig, and are only one of five separate types of air and gas handling units manufactured by Allis-Chalmers.

For detailed information on an air or gas handling unit to fit your particular need, contact your nearest A-C sales office or write Allis-Chalmers, Milwaukee 1, Wis.

A-4115



An air blast PORTADRILL rig using a Ro-Flo compressor on location in the Wyoming desert. Unit is drilling blast holes for strip mining.

Ro-Flo and *Texrope* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Petroleum Industry

TURBINE-GENERATORS · BLOWERS and COMPRESSORS · TRANSFORMERS · UNIT SUBSTATIONS · MOTORS—*TEXROPE* DRIVES-CONTROL · CENTRIFUGAL PUMPS

Are your high temperature tubes giving you the best life/cost ratio? *Ask the experts!*

This month's report is on: **DM STEEL**

Has unusually high creep strength for a pearlitic steel, good stability up to 1200° F., fairly good corrosion and oxidation resistance. Has 2 to 3 times the life of carbon steel where corrosion is not severe. Recommended for cracking furnace tubes, hot oil lines, superheater tubes, high temperature steam piping and forgings for accessory parts.

ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS

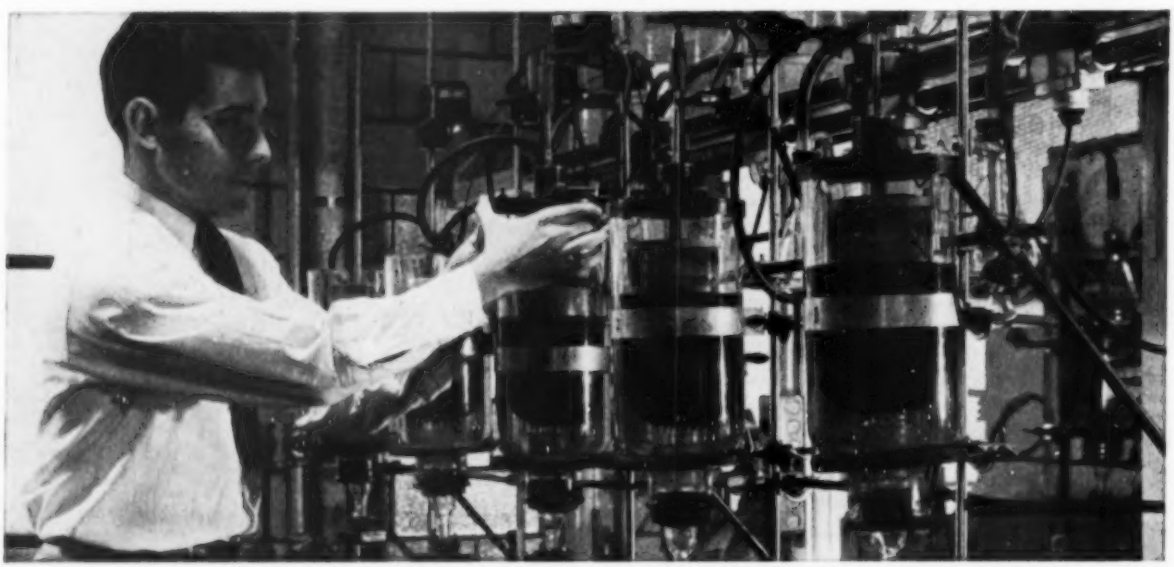
Carbon	Sicromo 2	Sicromo 5S	18-8 Ti
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	16-13-3
DM-2	2½% Cr.-1% Mo.	Sicromo 7	25-20*
Silmo	Sicromo 3	Sicromo 9M	25-12*
DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

**Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

CHANCES are there are several high temperature tube steels that will solve your particular combination of heat, pressure, oxidation and corrosion problems. But there's only *one* analysis that will give you the best life/cost ratio.

The best way to find that one steel is to *ask the experts*—metallurgists of The Timken Roller Bearing Company. They're recognized authorities on high temperature steels, backed by 20 years' experience. With 24 different analyses to choose from, they'll help you pick the steel that's best suited for your particular application. And you'll be assured of uniform quality in every tube because the Timken Company rigidly controls the quality of the steel from melt shop through final inspection.

Let the Timken Company's RSQ—Research, Supply, Quality—solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Electrolytic equipment used in Timken Company laboratories to extract non-metallic inclusions from steels in research on steel cleanliness.

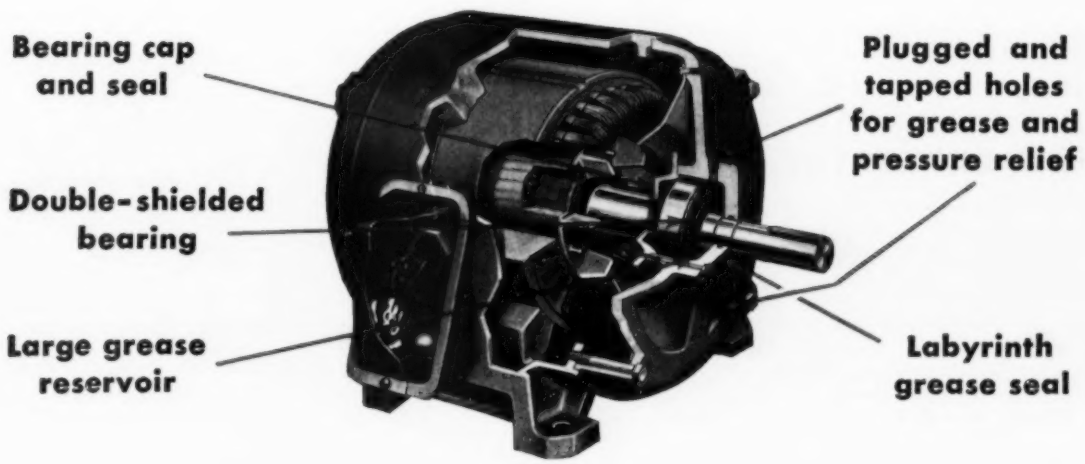
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Here Are Facts You Should Know About Electric Motor Bearings

An ideal motor bearing would operate for indefinitely long periods under all types of conditions without requiring any attention whatever. However, in the opinion of our engineers, such a bearing and its attendant lubricant are not yet available on the commercial market. Consequently, bearings for many types of operations, particularly where overloading, extreme temperature ranges and chemical and dirt laden atmospheres are involved, require special lubricants or regular lubrication schedules.

Of course, bearings suitable for many kinds of operation under normal conditions can be built to require no attention for very long periods — usually several years. Allis-Chalmers can supply sealed bearings in all frame sizes through 505 on short delivery and without extra cost for applications of this type.


Bearing cap and seal
Double-shielded bearing
Large grease reservoir
Plugged and tapped holes for grease and pressure relief
Labyrinth grease seal

Which is the Best Design for *Your* Application?

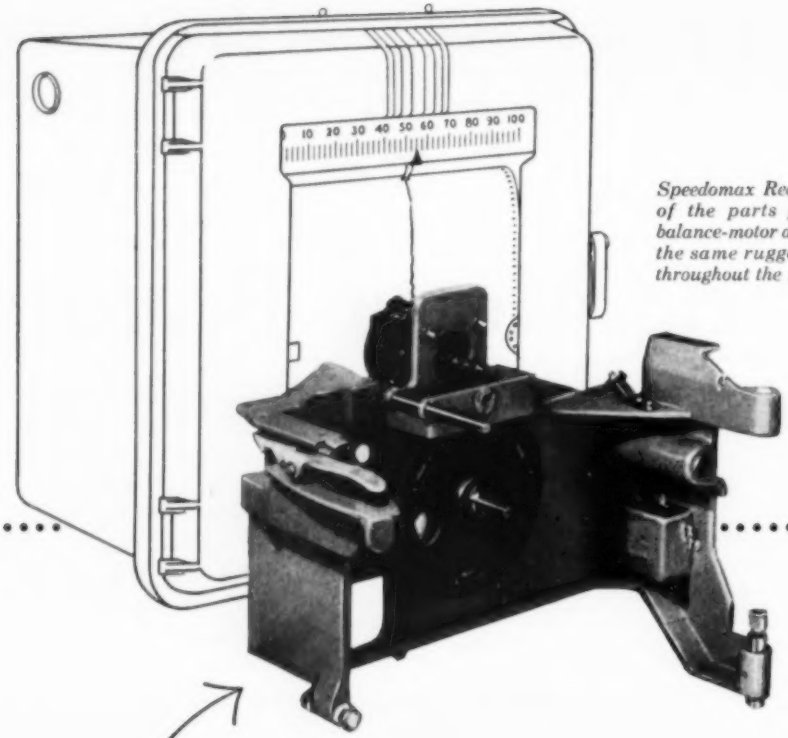
But, we believe that the design used in standard Allis-Chalmers drip-proof, tefc and explosion-proof motors represents the best design for most industrial users.

The Allis-Chalmers standard design consists of a prelubricated, double-shielded bearing mounted in the end housing with a generous grease reservoir. Plugged and tapped holes are provided for grease and for pressure relief. Under normal operating conditions, this design will operate as long without attention as any other type of bearing in use today. But where difficult operating conditions make relubrication desirable, it can be done as part of the normal lubricating-routine without dismantling the motor.

The large grease reservoir and shielded bearing design assure that grease lost from the bearing due to high operating temperatures or other causes will be replaced automatically.

For further information on bearing design and other features of Allis-Chalmers motors, call your nearby Allis-Chalmers District Office or Authorized Distributor. A-4130

ALLIS-CHALMERS



Speedomax Recorder and a few of the parts for its circuit-balance-motor drive. You'll find the same rugged construction throughout the instrument.

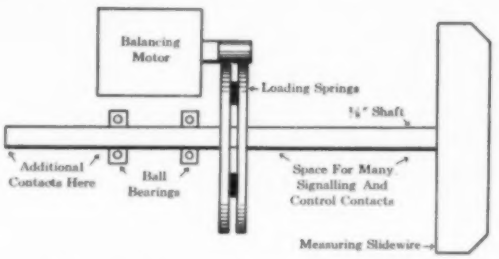
RIGID CONSTRUCTION MEANS Rigid Dependability

● When you turn a measuring or control job over to a Speedomax instrument, much of the good performance you receive is due to the strong, carefully-assembled mechanism controlled by the sensitive electronic circuits. Seasoned, time-proved mechanical design is evident as soon as you open the instrument door.

For instance, just rotate the "big" balancing-gear train with your fingers. You won't detect back-lash. The train will turn at a touch, but those two 1⅛" face, spring-loaded gears are held so snugly against the pinions, in opposite directions, that they answer every tiny balancing motion in either direction. The slightest nudge from the "huge" 12-watt balancing motor therefore goes straight to the slidewire, recording and control mechanism via their common shaft. The tying of these functions to one shaft assures permanent alignment of recording, control and measuring functions.

The paper drive and some other components get their positive action in another way. They use machined, heat-treated worm gearing for snug fit and precise motion. Ability to use such designs is one of the many advantages of the instrument's ample power. Liberal use of ball bearings is another quality feature, to transmit full power, reduce routine attention and maintain operating precision.

As you look further into a Speedomax, you'll also note that many parts such as frame castings, shafts, linkages, etc., seem very large. But there's a strong reason for this seeming oversize—it prevents mechanical deflections in operation. Rigid construction gives rigid dependability.



The Speedomax Mechanism "Heart" Is Just 2 Assemblies

Why not inspect these and other evidences of quality the next time you need an electronic potentiometer or bridge. You can easily check them against the general description in our Catalog ND46(1). If you're interested in research, ask also for Technical Publication ND46(1). Address our nearest office, or 4923 Stenton Ave., Philadelphia 44, Pa.

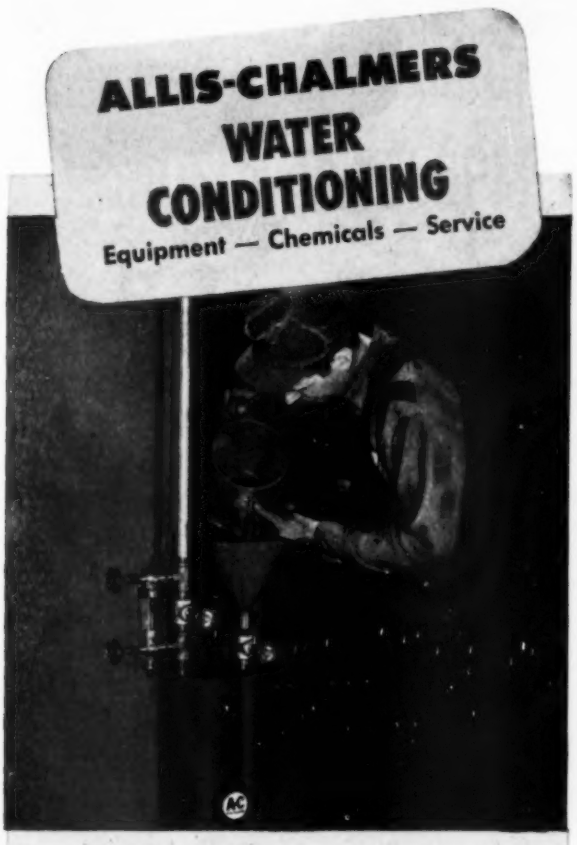
LEEDS NORTHRUP

instruments *automatic controls • furnaces*

(In Ad ND46(11))

How to Solve Boiler Problems caused by

HIGH CIRCULATING RATES



Equipment for all water treatments is available from Allis-Chalmers. Picture shows feeder installation similar to equipment used in water side protection of boiler surfaces.

Recent trends toward high circulating and high heat transfer rates mean that careful attention to water side protection of boiler surfaces will pay off in lower fuel costs and easier maintenance. Information that will help you analyze this problem and work out an effective solution is contained in Allis-Chalmers water conditioning Bulletin 43. It explains the problem. It tells what solution is available. And it tells how to apply this solution.

Based on Allis-Chalmers Experience

Bulletin 43 is one of a series of Allis-Chalmers bulletins on water conditioning problems. Each of these bulletins contains information that will help you solve some of your problems. They are based on Allis-Chalmers wide experience handling water problems for nearly every industry. In addition, they are based on Allis-Chalmers long experience building steam turbines and power plant equipment.

Complete Service Available

Allis-Chalmers gives you complete water conditioning service. You can get analyses and reports on your problems. You can get the chemicals needed in all water treatments. And you can get the equipment needed in any system.

A-4035

For your copy of Bulletin 43 on internal treatment for water side protection of boiler surfaces, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby Allis-Chalmers district office and have an Allis-Chalmers representative consult with you on your water problems.

ALLIS-CHALMERS

An unbeatable team for temperature measurement

DYNALOG RECORDERS and DYNATHERM BULBS

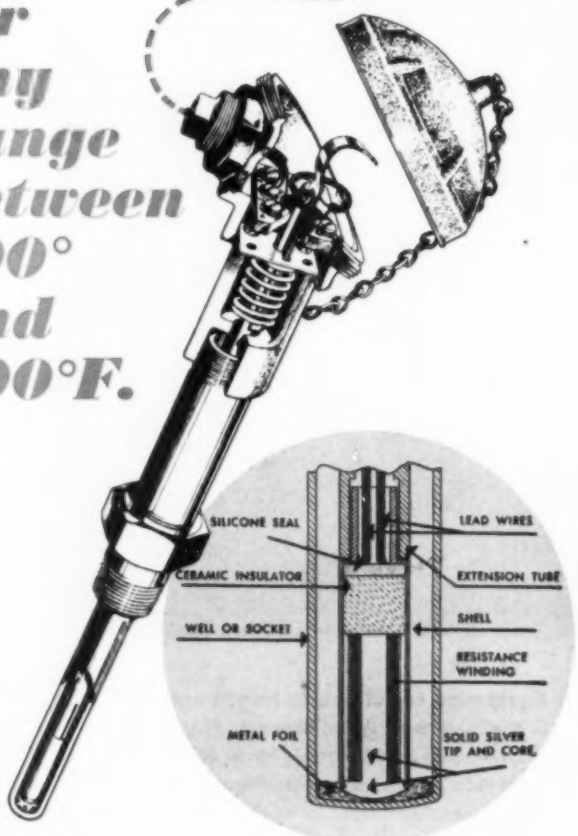
You can't beat this Foxboro Dynalog-Dynatherm combination for insuring better temperature measurement on any job between–100° and+600°F. It gives you every advantage of speed, accuracy, long leads, simple installation, economy, and freedom from maintenance. This is why:

The Dynalog Electronic Recorder has an exclusive variable-capacitor measuring system which eliminates slidewires, gears, cables, high speed balancing motors . . . no dead space, no batteries to standardize, no motors to service. Standard full-scale pen speed only 3 seconds. Sustained accuracy ¼ of 1% guaranteed. Available for spans as narrow as 5°F. with full-accuracy calibration.

The Dynatherm Resistance Bulb has unique features including metal-to-metal end-contact which, when installed in a well or socket, gives a speed of response unsurpassed by any other similarly protected temperature-sensitive element. Exceptionally rugged and permanent in calibration.

These are only a few of the important advantages of this better temperature measuring system . . . available also for control of temperatures, or with Multi-Record Dynalog Recorder for up-to-6 records on one chart. Write for illustrated bulletins, The Foxboro Company, 748 Neponset Ave., Foxboro, Mass., U.S.A.

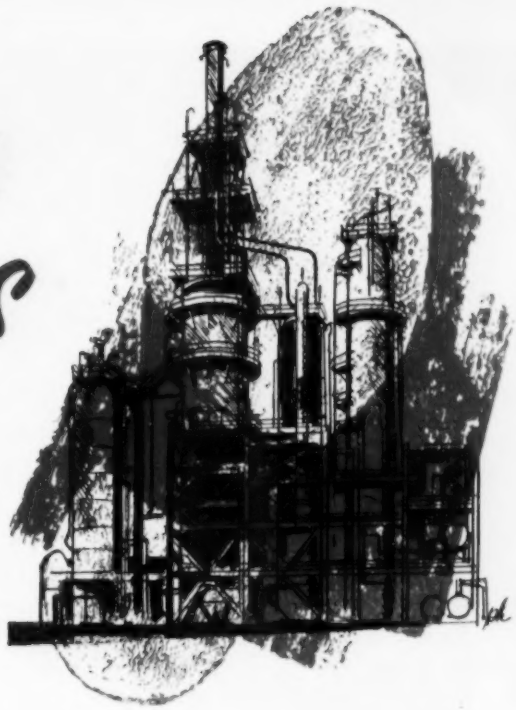
for any range between -100° and +600°F.

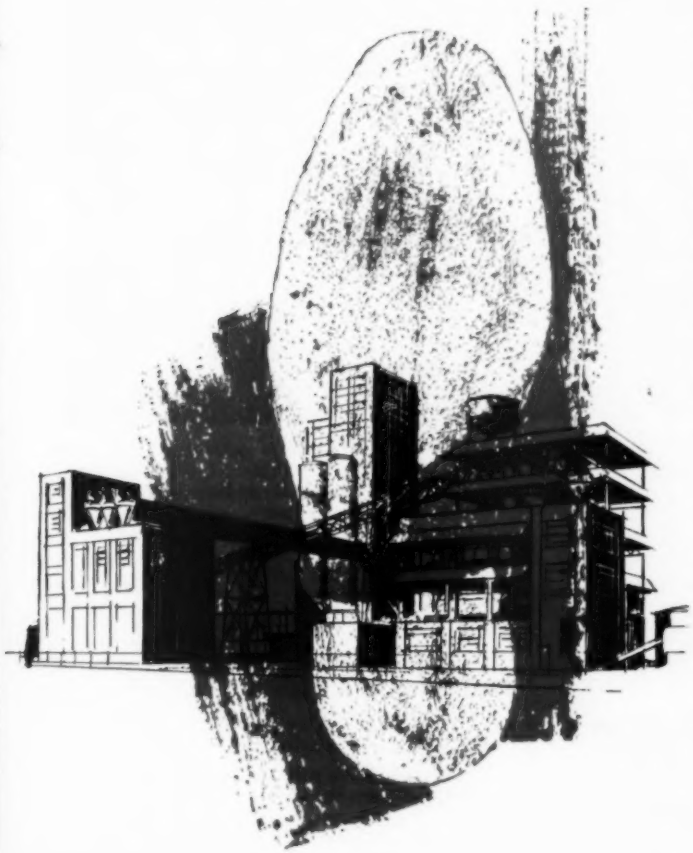


FOXBORO REG. U.S. PAT. OFF. **INSTRUMENTATION**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

BLAW-KNOX HAS MADE *GREAT STRIDES* IN BOTH CHEMICAL AND PETROCHEMICAL PROJECT DEVELOPMENT





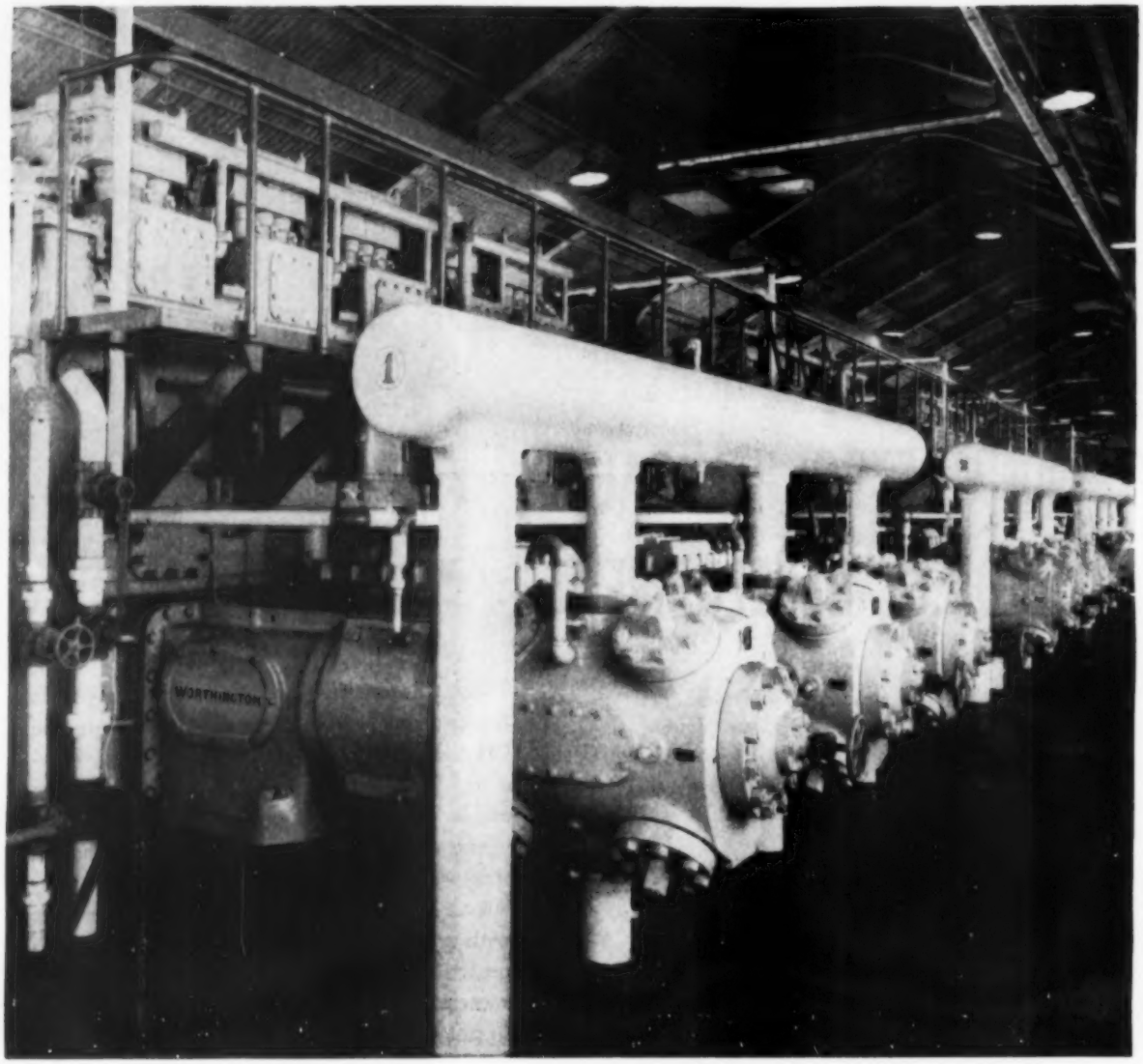
Time was when Blaw-Knox Company was noted chiefly for its outstanding work in the Chemical and Processing fields. Today, however, Blaw-Knox Chemical Plants Division can look back on the pioneering role it played in the young petrochemical industry! Much of this work was "unorthodox" but not speculative. In every instance, the client came to us with a problem he wanted solved. We engineered an economical solution, and built a successful plant. We welcome the opportunity to put this experience behind any project you may be contemplating.

PLANTS & PROCESSES

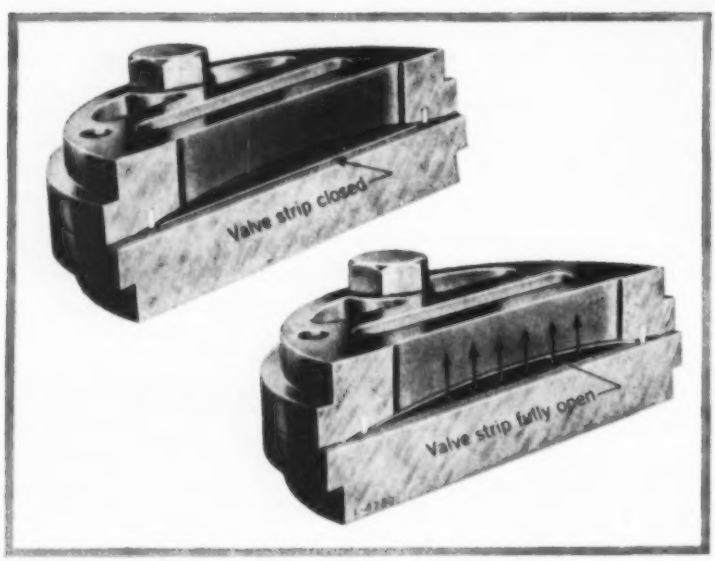
Catalytic Reforming • Catalytic Cracking • Decarbonizing • Waste Disposal • Crude Distillation • Ethylene Oxide • Fischer-Tropsch Oxo • Caustic Soda & Chlorine • Extraction • Fractionation • Package Gasoline Stripping • Recycling • Alkylation • Resin Polymerization • Tonnage Oxygen • Synthetic Fuels

BLAW-KNOX COMPANY
CHEMICAL PLANTS DIVISION
120 EAST NINTH ST. • TULSA 10, OKLAHOMA
Pittsburgh 30 • Philadelphia 3 • Birmingham 3
New York 17 • Chicago 1 • Washington 5, D.C.
San Francisco 5

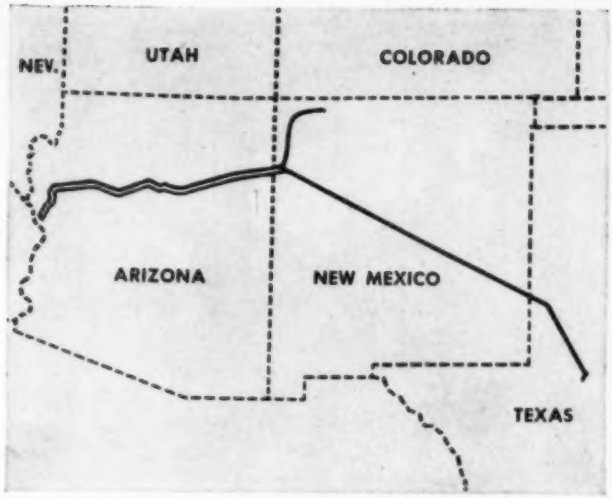
BLAW-KNOX



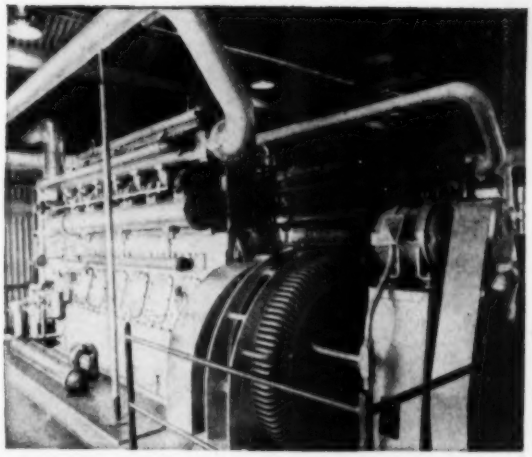
10,000 HORSEPOWER IS DELIVERED by these ten Worthington UTC Engine-Compressors in the Navajo Station on the El Paso Natural Gas line. Two 2000-hp Worthington UTC compressors are planned for the company's pending expansion at this station. They will handle a total of 687,000,000 cubic feet of gas when the installation is completed.



FEATHER® VALVE USED EXCLUSIVELY in Worthington compressors seats by contact, not by impact; ends remain in contact with the seat at all times. It operates quietly, efficiently, and with minimum maintenance.



PROPOSED 792 MILE, 30" PIPELINE to add 400 million foot capacity will run from the Permian Basin in Texas to Franconia, Arizona. The Navajo Station, largest in the line, will use a total of thirteen Worthington UTC Engine-Compressors.



ELECTRIC POWER for the Navajo compressor station is supplied by these two Worthington type CCG-6 gas engines which drive Electric Machinery generators. Such an economical means of generating power should not be overlooked when compressor stations are planned. Another CCG-6 is planned to supply additional power at the Navajo Station.

13 Worthington UTC Engine-Compressors planned for new El Paso Natural Gas line

The El Paso Natural Gas Company plans to install 13 Worthington Uniflo two-cycle engine-compressors on its new 792-mile line if the project is approved by the Federal Power Commission. These are in addition to the 18 units that the company already has in operation or in process of installation on this line.

The new 30-inch main transmission line will originate in the Permian Basin and extend in a northwesterly direction across New Mexico to a point near Gallup. There junction will be made with the existing 24-inch main transmission pipe line from the San Juan Basin. From that point west, the new 30-inch line will loop the present San Juan line to a point close to Franconia, Arizona, near the California border. This line will make possible additional deliveries totaling 400 million cubic feet of gas per day; 300 million cubic feet per day coming from the Permian Basin and 100 million cubic feet per day from the San Juan Basin.

The Navajo and Leupp compressor stations, first and second to handle the full 687 million cubic feet per day (the San Juan system is currently authorized for 287 million cubic feet per day) are both fully equipped with Worthington UTC Engine-Compressors exclusively.

Standard equipment on Worthington UTC's is the exclusive Feather* Valve—a factor that contributes materially to long life and trouble-free performance. The Feather Valve has long been recognized as the lightest, tightest, most durable and efficient valve obtainable.

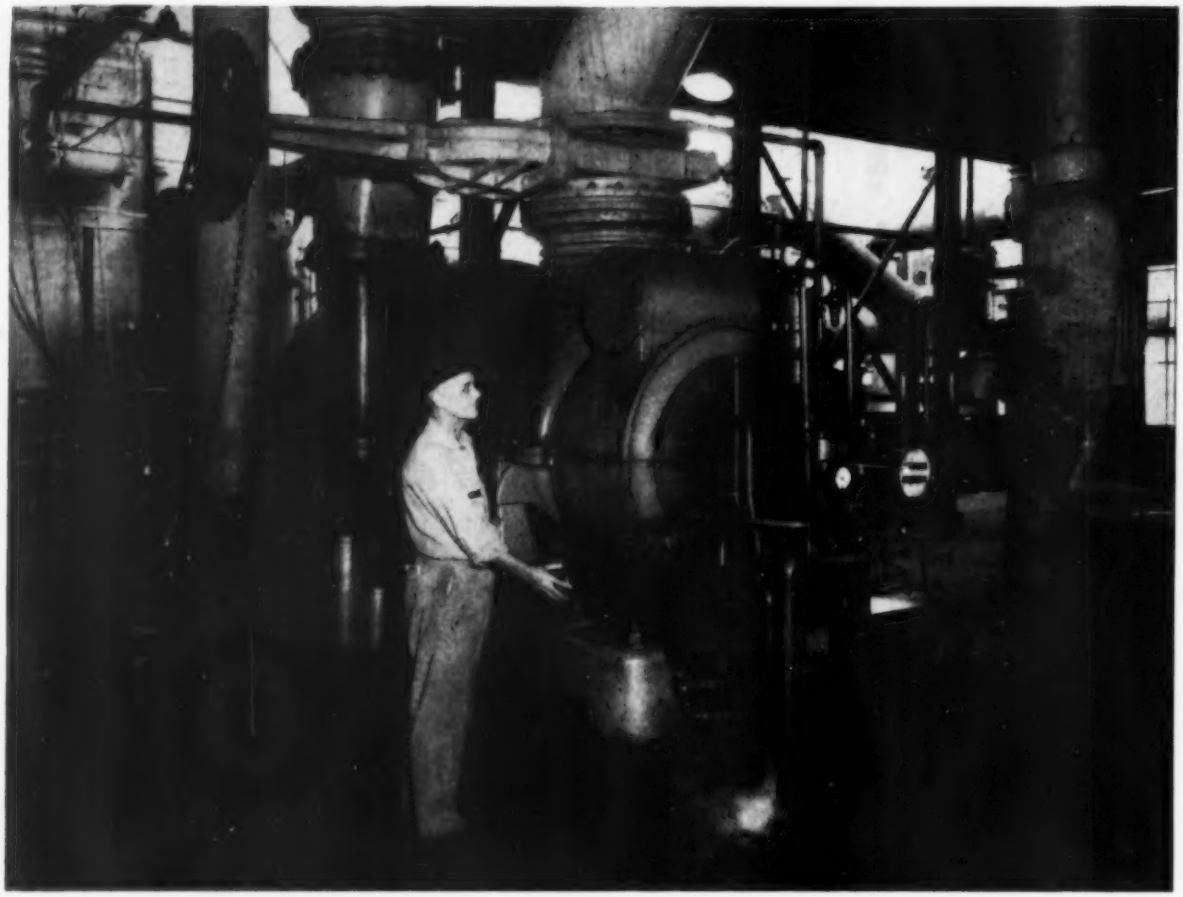
While Worthington UTC compressors are widely used for pipeline gas compression, they are also well suited to many other jobs, such as pressure maintenance on oil wells; varied service in natural gasoline plants; solvent extraction, vapor recovery, and recycling and stabilization of gases in oil refineries.

If your business requires gas compression, it will pay you to write for further information on the Worthington UTC Engine-Compressor. Sizes range from 1,000 to 2,000 hp. Write to your nearest Worthington district office for Bulletin S-500-B23B. Or write directly to Worthington Corporation, Engine Division, Buffalo, New York. EK.3.2

*Reg. U. S. Pat. Off.

WORTHINGTON

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



WORTHINGTON 550-HP TURBINE, used to drive coke oven gas collection blower, is one of two units purchased by the Citizens Gas & Coke Company of Indianapolis. The first unit, installed in 1938, operated continuously until 1945, when the second unit was installed. Now the units alternate, providing continuous service.

Operating record of this Worthington blower-drive turbine brought repeat order

Fifteen years of dependable service and still going strong. That's the record of this 550-hp Worthington turbine, used for driving a coke oven gas collection blower.

The unit was purchased by the Citizens Gas & Coke Company of Indianapolis, Ind., early in 1938. Impressed by its performance, Citizens Gas & Coke installed another Worthington turbine in 1945 to drive a similar blower.

The long satisfactory experience that Citizens Gas & Coke has had with these turbines is duplicated by Worthington users everywhere.

Worthington turbines are ideally suited for blower or centrifugal compressor drives, since they are available in all sizes and speeds to give the most economical unit performance. Another advantage is the turbine's adaptability to various governing arrangements for precise control under all operating conditions.

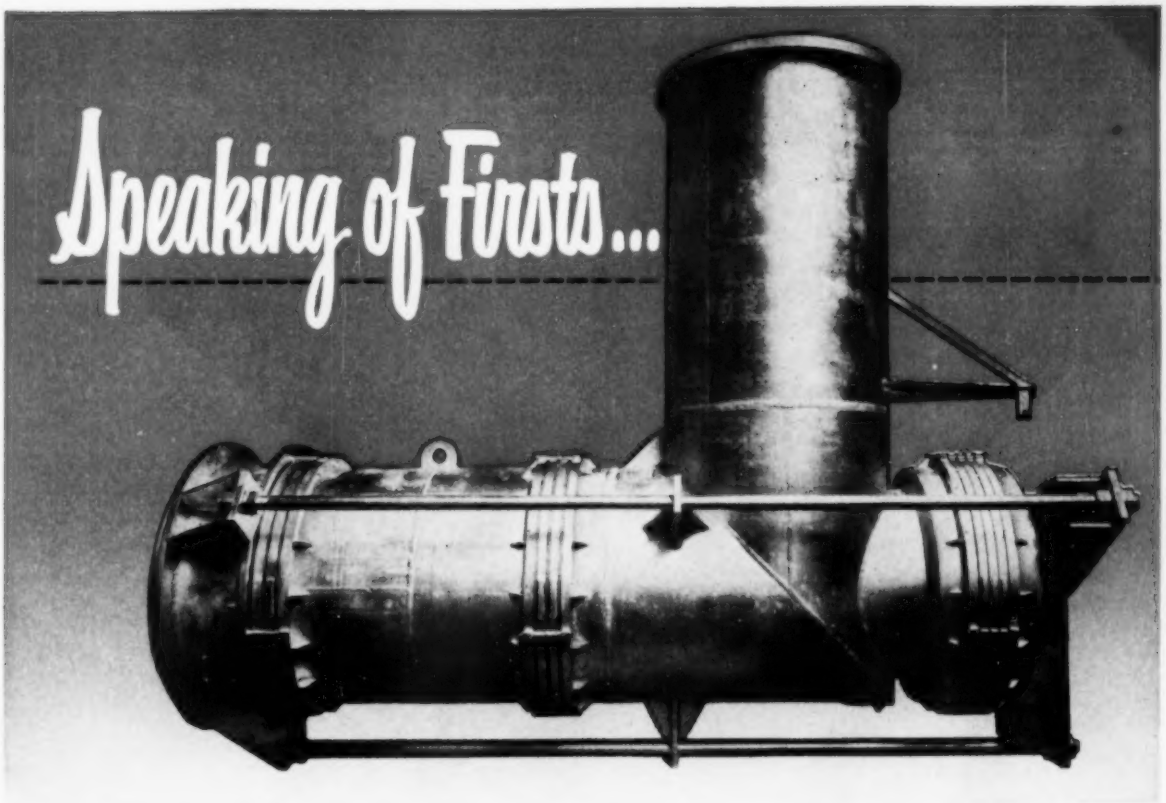
Remember, the engineering of the drive is just as important as the engineering of the compressor or blower. Worthington's long experience in compressor-drive engineering is your assurance of getting exactly the *right* type and size drive for your needs. Write for Bulletin 1966 to Worthington Corporation, Steam Turbine Division, Wellsville, N. Y. T.3.3

A GREAT TEAM IN STEAM

WORTHINGTON

Steam Turbines

Speaking of Firsts...



Recently, Zallea was given the assignment of developing a group of 48-inch expansion joints for flight propulsion test facilities on a classified defense project. The rigid technical specifications of this advanced application required "tailor-made" units for the job, so Zallea engineers analyzed the problem and designed the unusual-looking joint pictured above . . . the first of its kind. Actually, it is a Balanced Pressure, Universal Self-equalizing expansion joint, originally developed by Zallea engineers in 1945, operating at 165 psi and incorporating internal stainless steel turning vanes to provide a smooth flow of gases through the right angle bend. The unit absorbs 3" axial and 1.27" lateral movements through a temperature range from −100° F. to +650° F. No anchors are required since this arrangement neutralizes end thrust developed by internal pressures.

This example is representative of our ability to cope with the most difficult expansion joint problems. It is our business to specialize in the design and manufacture of one product only—expansion joints—and over the years we have learned how to solve the "tough ones" effectively and quickly.

Zallea Expansion Joints are available in diameters from 3 inches to 30 feet . . . for temperatures from sub-zero to 1600° F. . . . for pressures from vacuum to 300 psi in standard designs, and up to 2,000 psi in special designs.

The next time you are faced with an expansion problem, get in touch with us. We will be glad to survey your situation and recommend the most practical and economical solution. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

For detailed information on Zallea Expansion Joints and services write today for a free copy of Bulletin 351.

Zallea
EXPANSION JOINTS

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

RINGS. *Sizes:* From 3/32" I.D. x 3/16" long x 7/32" O.D. to ½" I.D. x 1" long x 1" O.D.

PELLETS. *Sizes:* From ⅛" x ⅛" to ½" x ½".

Rx for shorter contact time!

SPHERES. *Diameters:* ¼" to 1".

Norton specially engineered carriers bring proved advantages to a wide range of processes

Whatever your specific application may be, it will pay you to investigate the many advantages of Norton catalyst carriers.

Made of ALUNDUM* (fused alpha alumina), these highly refractory carriers are outstanding for heat conductivity, chemical inertness, mechanical strength and abrasion-resistance. And Norton's exclusive *controlled structure* process offers you a choice of porosities. In pellets and rings, porosities range from medium to high. In spheres, porosities range from medium, with rough exterior for coating with catalyst... to high, with a network of open pores and rough exterior for impregnating with catalyst.

Chemical engineers are finding this Norton "Special Refractory Prescription" invaluable in processing many different products. For example, in meeting the rapidly growing demand for phthalic anhydride, Norton catalyst carriers aid in shortening catalyst contact time and in achieving the highly exothermic reaction in fixed bed converters.

Test Them Out

Find out just what Norton ALUNDUM catalyst carriers can do for you. See your Norton Representative for samples, or write to NORTON COMPANY, 467 New Bond Street, Worcester 6, Mass.

Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

Special REFRACTORIES

Making better products... to make other products better

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS

We're always glad to lend you a helping hand

This picture shows the Hindu triad performing the Dance of the Universe. The many different arms symbolize its many different powers—and remind us that Ethyl Corporation seems to have developed a few extra arms, too.

In thirty years of working with the petroleum industry, we have built up a powerful advertising arm, which was one of the decisive factors in stimulating public demand for premium gasoline, and is today helping you increase sales of this extra quality product. And we've backed up this arm with another which fashions movies, booklets, demonstrations, and other selling aids to help your service station people increase premium sales.

Then there's the Ethyl research arm which helps you squeeze the highest

(Continued on next page)

ETHYL
ETHYL CORPORATION

Printed in U. S. A.

We're always glad to lend you a helping hand

(Continued from preceding page)

possible octane number out of every ounce of TEL. And a gasoline testing arm which helps you measure and maintain the quality of your gasoline.

Our farm-program arm helped to develop an entirely new market for gasoline, and continually works to increase the size of this market.

Our statistical arm tabulates and delivers exclusive information on gasoline sales to help you analyze your own regular and premium sales.

And finally, Ethyl's automotive arm works constantly with manufacturers of auto, truck and bus engines to help them develop engines that will make more efficient use of your gasoline.

In short, we believe Ethyl is uniquely equipped to lend you a helping hand —and we're always happy to do so.

ETHYL CORPORATION

NEW YORK 17, NEW YORK

Ethyl service is backed by 30 years of antiknock experience

RESEARCH

SALES HELPS

SUPPLY SERVICE

ROAD TESTING

TECHNICAL REPORTS

GASOLINE TESTING

Better Valves–Year After Year

Fig. 375—200-pound Bronze Gate Valve with screwed ends, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze disc.

Because throughout more than a hundred years Powell Engineers have never been willing to "let well enough alone," the Powell Line of Valves has been continually improved and expanded to satisfy every new demand of industry.

That is why there is a greater variety of Powell Valves in service today than of any other make.

The Wm. Powell Company
Cincinnati 22, Ohio

Fig. 3003—300-pound Cast Steel O. S. & Y. Gate Valve.

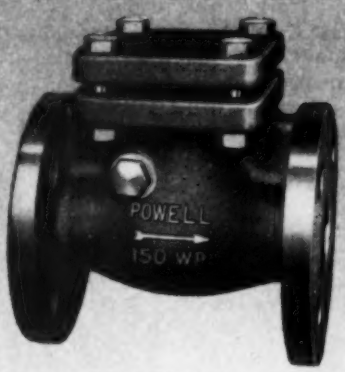


Fig. 2342—Stainless Steel Swing Check Valve for 150 pounds W.P. at 500F. Also made for 300 and 600 pounds W.P. at 800F. Available in other corrosion-resisting metals and alloys. Also furnished with screwed ends.

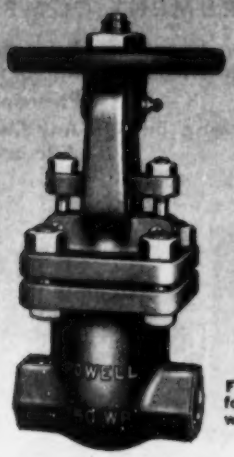
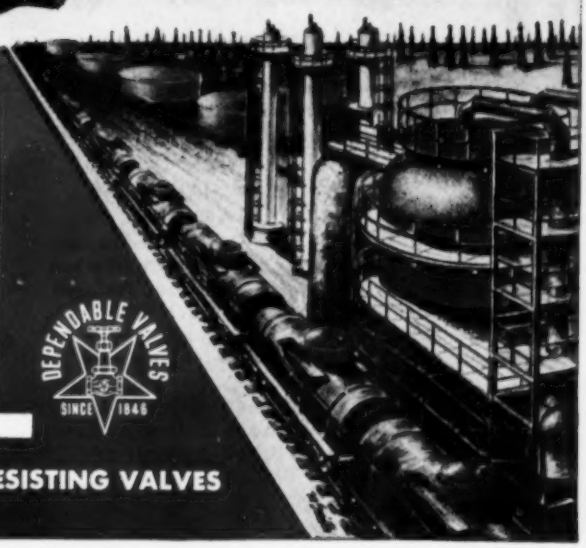


Fig. 2490—Stainless Steel O. S. & Y. Gate Valve for 150 pounds W. P. at 500 F. Can be furnished with solid or split wedge and with flanged ends.

POWELL

DEPENDABLE VALVES SINCE 1846

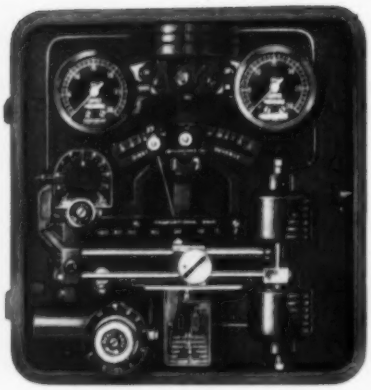
BRONZE, IRON, STEEL AND CORROSION RESISTING VALVES



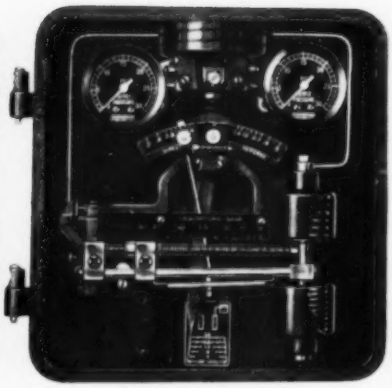
NEW MASONEILAN 12000 SERIES

Easy to Select

Proportional Controller



Proportional-Reset Controller



Pneumatic Transmitter

20 INSTRUMENT COMBINATIONS

Proportional Controller, which may also be used as a Transmitter, and which may be converted *in the field* to a

Differential-Gap Controller by changing one piece of air tubing or to a

Proportional-Reset Controller by simple addition of the reset unit. Also

Pneumatic Transmitter; or if desired

Any Combination of Two of these — same or different units — in a larger case

Right Hand Mounting on Integral Chamber

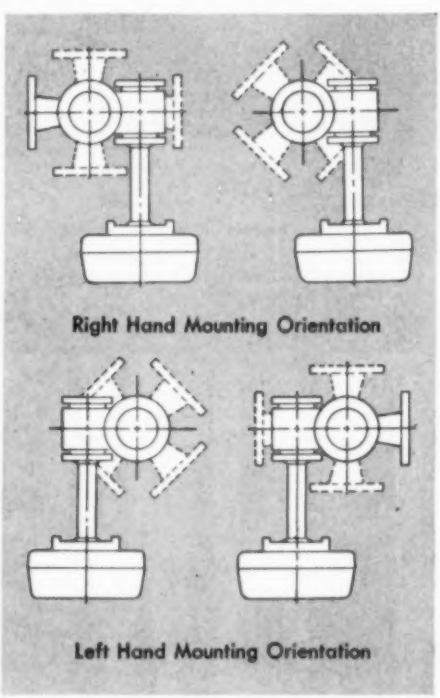
2 INSTRUMENT LOCATIONS

The instrument may be mounted to left or right of the displacer — at the factory — or in the field. No special tools — no extra parts required.

2 DISPLACER CHAMBERS 8 ORIENTATIONS

The instrument may be oriented to connections in any of eight positions when one or more side connections are used. *Mid-flange* in displacer chamber permits field orientation (or, if preferred, integral chamber with factory orientation can be supplied). Top and bottom connections permit installation of *integral* chamber in any desired position.

Left Hand Mounting on Mid-flange Chamber



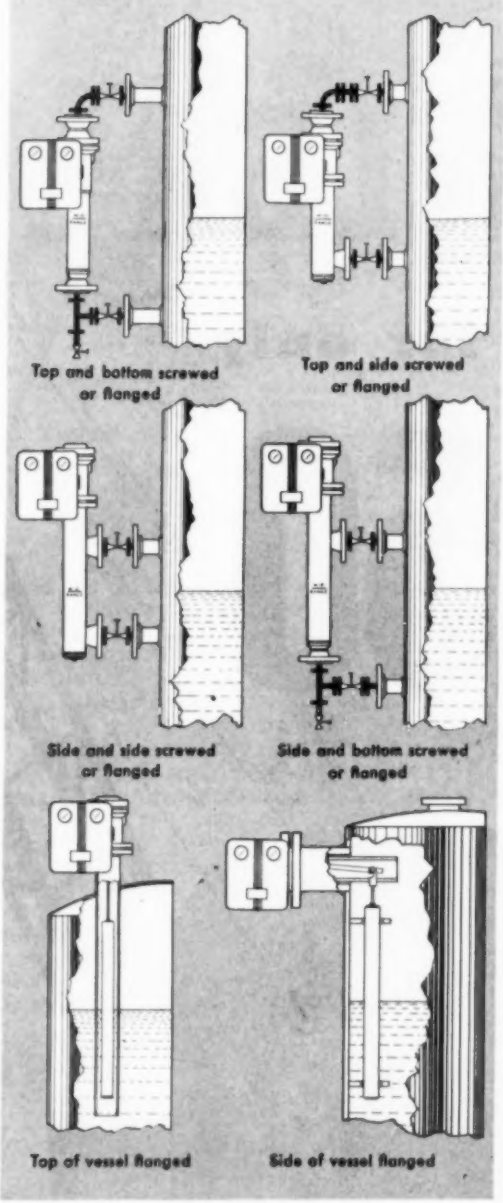
OVER 1,000,000

LIQUID LEVEL CONTROLLERS

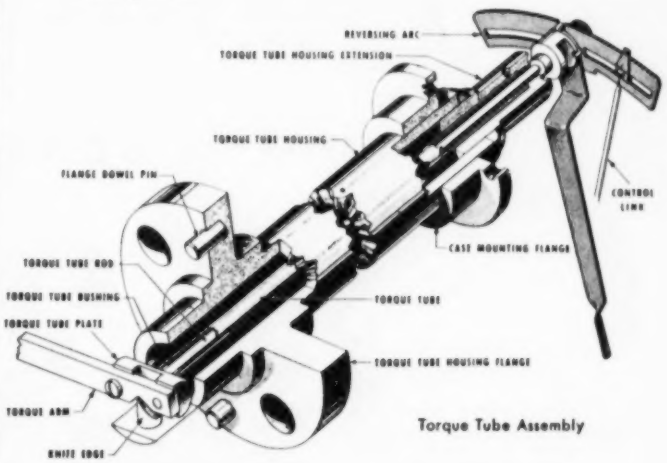
and Install

10 TYPES MOUNTING CONNECTIONS

A type to meet requirements of any vessel


Top and bottom screwed or flanged
Top and side screwed or flanged
Side and side screwed or flanged
Side and bottom screwed or flanged
Top of vessel flanged
Side of vessel flanged

Save time — save money! Masoneilan 12000 Series offers widest scope of selection plus design features that permit installation without delay and cost of precise preliminary layout. Convertibility *in the field* — of type of control and of orientation of instrument position to displacer and to chamber connections simplifies selection and installation. Simplified dimension schedule further assists in installation plans.



Torque Tube Assembly

9 TORQUE TUBE MATERIALS

Inconel (standard), K-Monel, Monel, Type 316 Stainless Steel, Hastelloy B or C, Nickel, Phosphor Bronze, Durimet 20.

CHAMBER or FLANGE MATERIALS

Iron, Bronze, Carbon Steel or various* Alloys available on some chamber or flange types — carbon steel or alloys on all types

*e.g. Stainless Steel, Monel, Nickel, Hastelloy, etc.

8 STANDARD RANGES

14″, 32″, 48″, 60″, 72″, 84″, 96″, 120″

Special ranges available

ALL HIGH Quality Control PRODUCTS

MASONEILAN REGULATOR CO.

1182 Adams Street, Boston 24, Mass., U. S. A.

POSSIBLE COMBINATIONS

WE'RE SO PROUD TODAY...WE'VE GOT

A NEW BANTAM®

IT'S A CRAWLER

and it sells for only

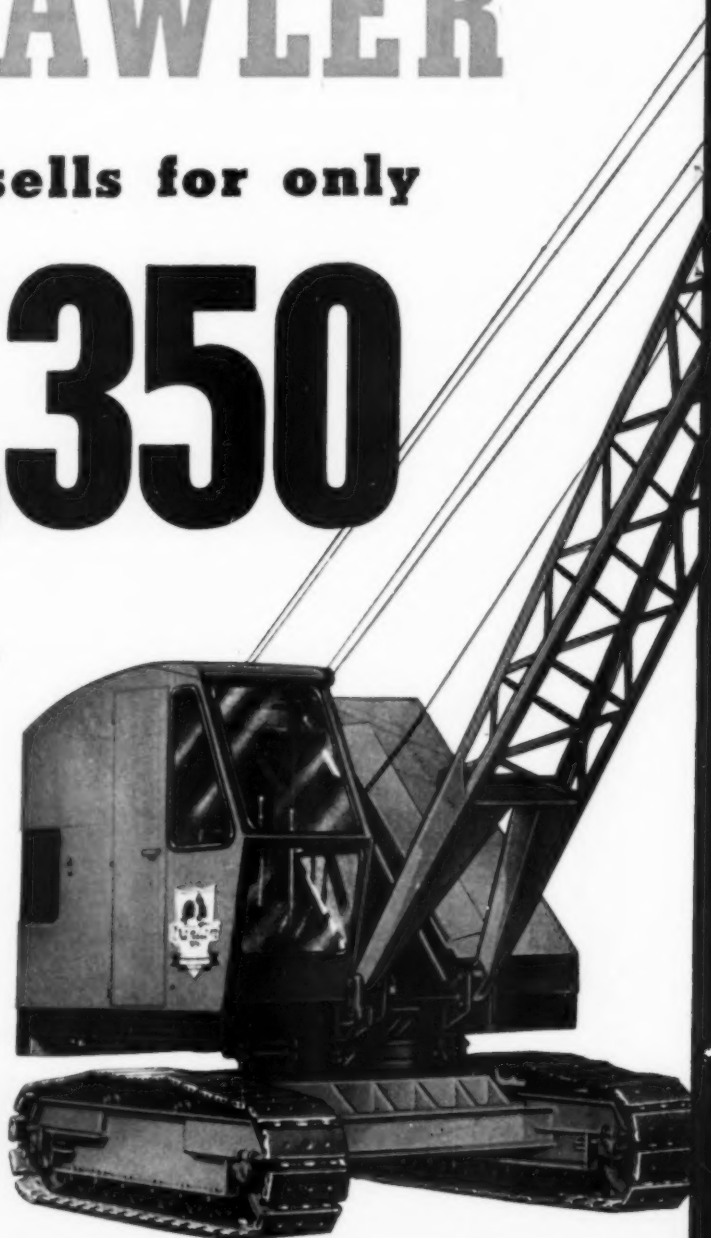
$9,350

F.O.B. FACTORY—BASIC CRAWLER WITH 1400 LB. COUNTERWEIGHT, LESS ATTACHMENT
Price Subject to Change

Your Schield Bantam Distributor is Scheduling On-The-Job Demonstrations Right Now...

See Him Today!

(or write factory to set a date)

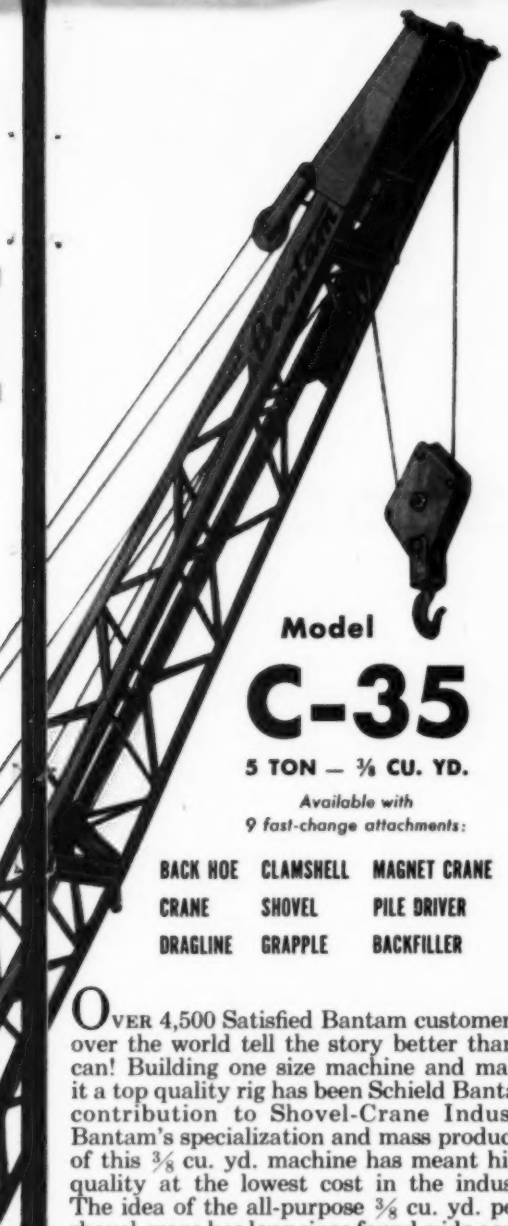


ANOTHER NEW PRODUCT OF

SCHIELD Bantam

WORLD'S LARGEST PRODUCER OF TRUCK-CRANES AND EXCAVATORS

...JUST LOOK WHAT YOU GET!



Model

C-35

5 TON — ⅜ CU. YD.

Available with 9 fast-change attachments:

BACK HOE	CLAMSHELL	MAGNET CRANE
CRANE	SHOVEL	PILE DRIVER
DRAGLINE	GRAPPLE	BACKFILLER

✓ 2-SPEED INDEPENDENT TRAVEL—enables the operator to move at varying speeds, forward or reverse, while operating the front end attachment.

✓ LOW GROUND BEARING PRESSURE—2 pad sizes available. 5 lbs. per sq. in. with 16" pads—3⅓ lbs. per sq. in. with 24" pads.

✓ BIG MACHINE STABILITY—longer, wider tracks—and a low center of gravity gives greater lifting capacity.

✓ HIGH SPEED OPERATION—features immediate acting straight mechanical controls, easy positive braking action, fast line and swing speeds.

✓ FAMOUS BANTAM FEATURES—power boom hoist, machine cut gears, anti-friction bearings, 4 hook rollers, greater visibility.

✓ 94-INCH OVER-ALL WIDTH—allows the Bantam to be moved from job to job on standard trailers without special highway permits.

OVER 4,500 Satisfied Bantam customers all over the world tell the story better than we can! Building one size machine and making it a top quality rig has been Schield Bantam's contribution to Shovel-Crane Industry. Bantam's specialization and mass production of this ⅜ cu. yd. machine has meant higher quality at the lowest cost in the industry! The idea of the all-purpose ⅜ cu. yd. power shovel-crane has long since found wide acceptance. NOW . . . you, too, can receive the rewards from this great American idea by letting Schield Bantam solve your lifting and excavating problems! **Whether your work calls for a crawler or a truck mounted crane-excavator, the BANTAM can do your job faster . . . better . . . cheaper! Write *today* for further information on the BANTAM for *your* jobs!**

Schield Bantam Co. 285 Park St., Waverly, Iowa

THIS, TOO, IS ALL NEW!

A BRAND NEW CRANE CARRIER CUSTOM BUILT BY A FAMOUS TRUCK MANUFACTURER

Model T-35 6 TON ⅜ CU. YD.

BACK HOE

Crawler working in solid mud . . . crawls out after trenching with no trouble. High flotation enables Bantam to work in any kind of underfoot conditions—muck, mud, sand, etc.

SHOVEL

Handles up to 100 cu. yds. per hour from stock-pile . . . up to 90 cu. yds. excavating in average material. Automatic dipper trip means quick, effortless dumping. Also available with ½ cu. yd. rehandling bucket.

DRAGLINE

Digs 90 cu. yds. per hour in average material, available with perforated or solid buckets. Ideal for gravel pits, ditch cleanout, cutting new drainage ditches, basement excavations, stock-piling, pits, etc.

CLAMSHELL

Ideal for stock-piling and loading out of stock-pile . . . precision excavating of bell holes, special excavating on pipeline jobs, cleanout of trenches. Handles up to 80 cu. yds. of average bulk material per hour.

...dollar per dollar

b.t.u. per b.t.u..... .....

PETROCHEM-ISOFLOW FURNACES

are most efficient by any comparison!

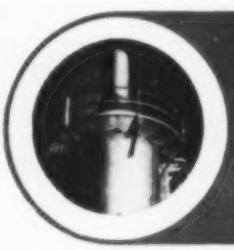
BETTER HEAT DISTRIBUTION
MAXIMUM FUEL EFFICIENCY
LOW PRESSURE DROP
LOW MAINTENANCE
ZERO AIR LEAKAGE
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
EXCESS DRAFT FOR HIGH OVERLOAD
PLENUM CHAMBERS FOR HAZARDOUS AREAS

simplicity of design and construction

The Isoflow Heater basically is a circular steel shell; this results in an explosion-resistant structure. The shell is lined on the inside with insulation and insulating refractories; this results in a wall with a zero air leakage and high efficiency. The vertical tubes are combined with integral convection tubes; this results in less headers in the heaters for complete cleanability. The integral radiant convection tubes and minimum number of headers result in a minimum pressure drop for a given velocity. The vertical tubes completely shield the walls resulting in low wall maintenance. The small number of headers in combination with the vertical tubes result in ease of cleaning and, if desirable, gang-cleaning of several tubes simultaneously. Individual burners, symmetrically spaced with relationship to the tubes, results in even heat distribution horizontally. The reradiant cone effects even heat distribution vertically. Segregated burners result in ease of firing and inspection of burners. These are some of the design features which place Isoflow Furnaces in a class of their own

—most efficient by any comparison.

More than 1150 are in operation throughout the world in the petroleum, chemical and allied industries . . . for all processes and for any duty, pressure, temperature and efficiency . . . and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.



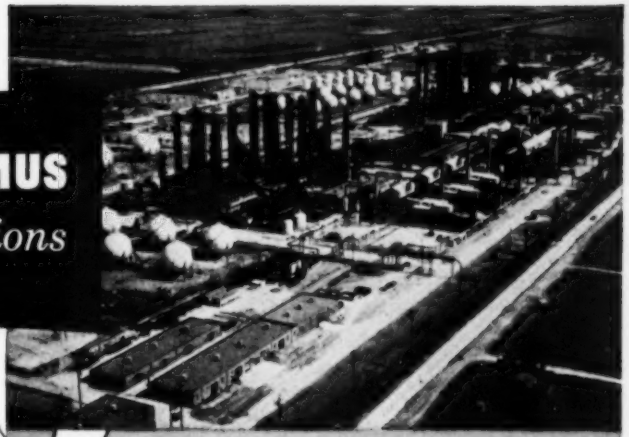
PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INCORPORATED
122 EAST 42ND STREET, NEW YORK 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston · Flagg, Brackett & Durgin, Boston · D. D. Foster, Pittsburgh · Faville-Levally, Chicago · Lester Oberholtz, California · Gordon D. Hardin, Louisville, Kentucky · Turbex Equipment Co., Narberth, Pa.

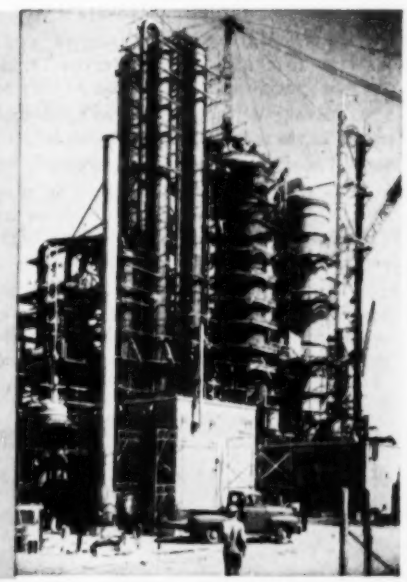
Chemical Plants by **LUMMUS** *...Assure Reliable Operations*



EXPERIENCE... Lummus' skill was achieved in designing and erecting upwards of 350 chemical plants all over the world. It took an experienced hand to create this butadiene plant, the world's largest—a big, tough job done under the critical press of wartime. Other similar early accomplishments are plants to make styrene, toluene, phenol, alcohol, ammonium picrate and catalysts.

PUTTING EXPERIENCE TO WORK TODAY. Today, Lummus is handling many different petrochemical and chemical projects—putting years of background experience to use in the light of today's competitive situations and technological advances. For example, the modern ethylene plant shown here is one of twelve Lummus projects in this field alone, including the world's largest unit. As a measure of engineering versatility, other recent Lummus projects are facilities for making phthalic anhydride, ethyl chloride, dichlorethane, formaldehyde, ethyl benzene, styrene monomer, isopropanol, phenol, acetone, carbon black, ammonia, aliphatic and cyclic alcohols.

SOMETHING YOU CAN USE. Lummus offers you competent experience in plants discussed on this page, as well as in modern process units for making such chemicals as ethylene oxide, ethylene glycol, acetylene, chlorinated hydrocarbons and urea.



If you're thinking of new or improved chemical facilities, Lummus can help you. A discussion with us may prove profitable to you.

LUMMUS

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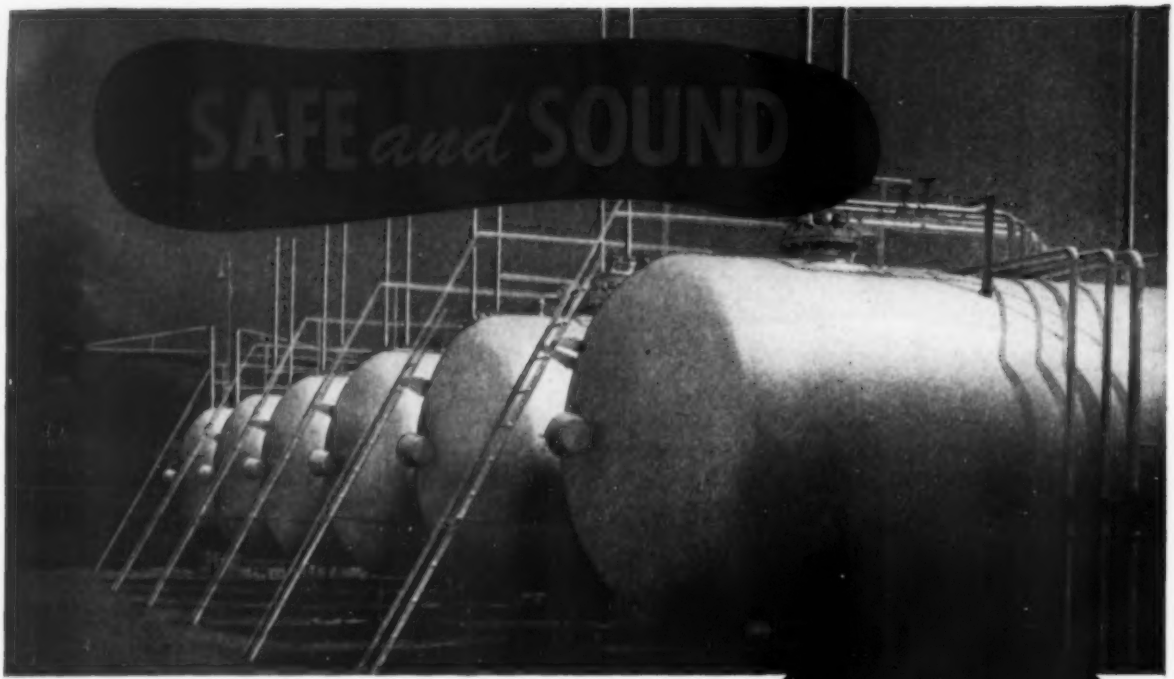
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



Here's what the Posey Iron Works offers to assure oil men of safety and soundness in pressure tanks:

1. A practical, workaday knowledge of peak loads . . . pressure . . . reserve capacities . . . fire protection requirements . . . steels . . . alloys . . . and specialized construction as they relate to the oil field.

2. Advanced inspection techniques that reveal flaws *prior* to shipment. These techniques include x-ray . . . hydrostatic . . . and hammer tests. Tanks are tested to a considerable excess over working pressures.

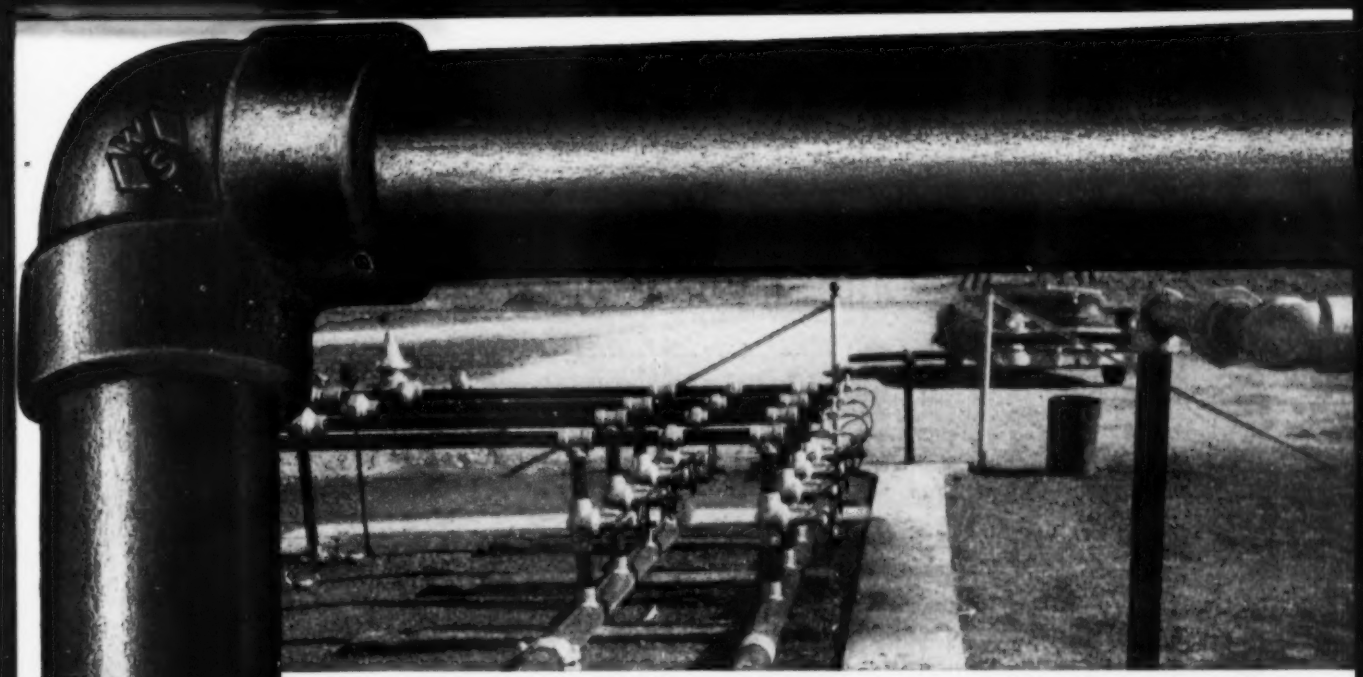
3. In welding Posey Iron tanks, only modern equipment and qualified welders are used. Edges of plates are always properly prepared. That's why tests unvaryingly show a high degree of joint efficiency in vessels built by Posey Iron.

4. Posey Iron construction fully meets the ASME code for unfired pressure vessels. Products are designed and built to comply with the requirements of the ASME; API-ASME; API and other codes. The Posey Iron Works is authorized to apply the appropriate code symbols.

"Play safe" — ask Posey to bid on your pressure vessels.

Alloy steel pipe fabricated by the Posey Iron Works for refinery use.

Fractionating column (awaiting shipment) for high octane aviation gasoline — 3' I.D. x 133' high.



STOP COSTLY PIPE-LINE FAILURES

No one knows better than you the increasingly high cost of unscheduled outages due to pipe-joint failures. But do you know just how far it is possible to go toward *eliminating* such failures throughout the life of your piping systems? The answer to this critical problem in production and maintenance costs is FORGED STEEL FITTINGS by the pioneer firm of Watson-Stillman—consultants and suppliers to *all* major industries concerned with pipe joining and maintenance.

Watson-Stillman fittings are FORGED for maximum strength, toughness, and resistance to corrosion, vibration, and shock. More uniformly precise in all dimensions, they are the modern go-between wherever pipes meet permanently.

Leading Refineries, Chemical Plants, Public Utilities, Refrigeration and Industrial Plants throughout the world stay on stream at lowest cost-per-year with the famous Double-Diamond Fittings by Watson-Stillman. Write for literature.

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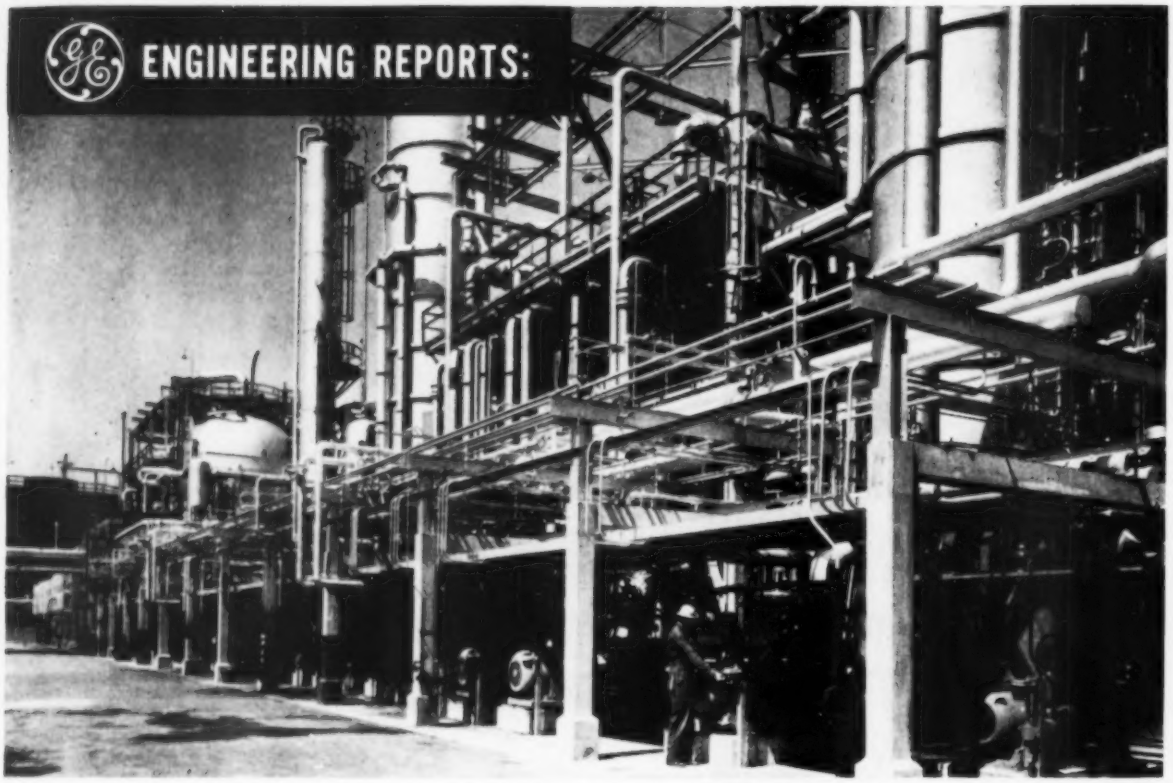
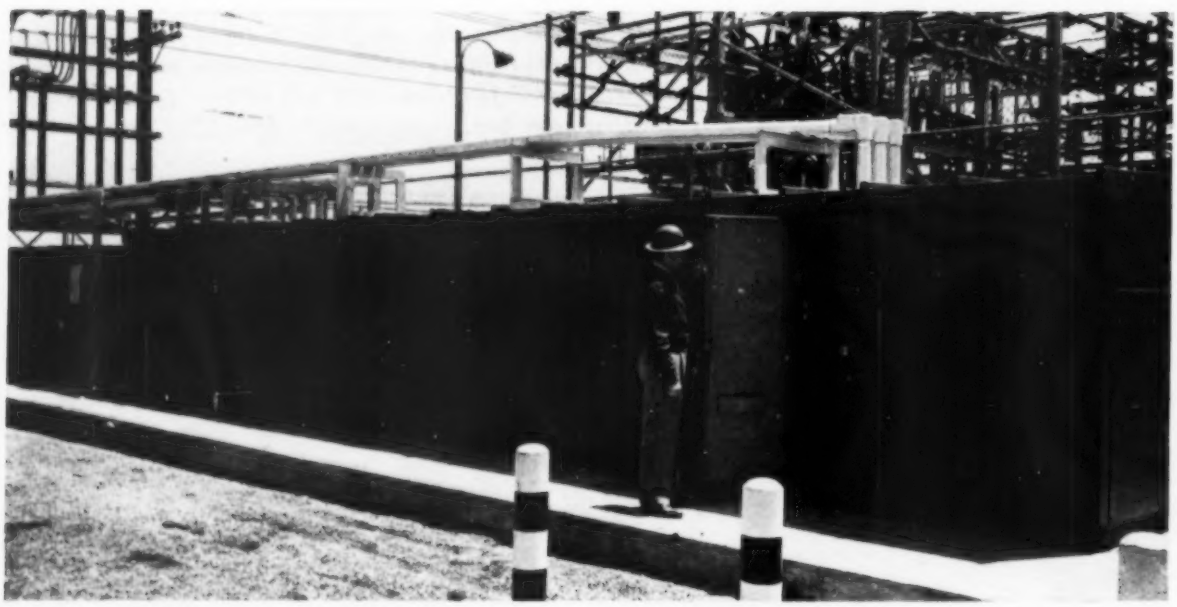


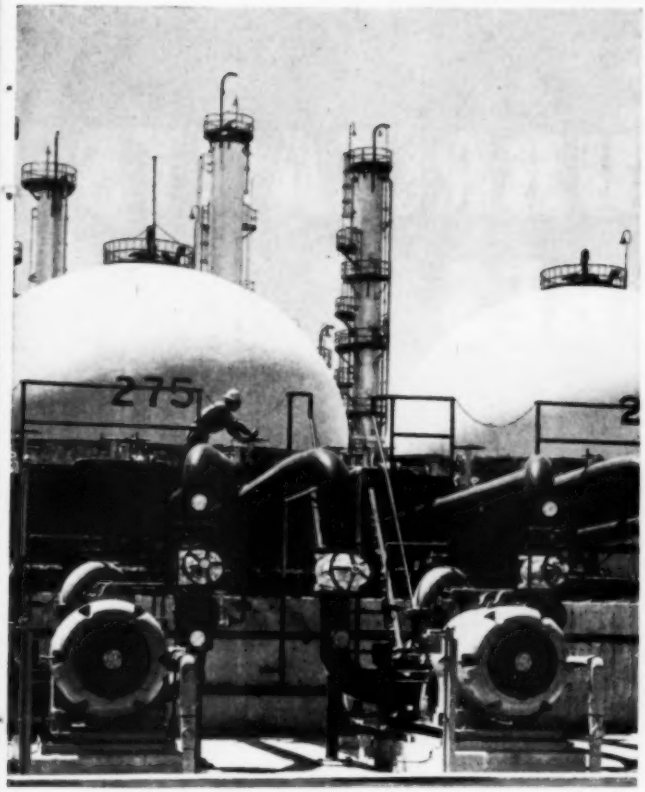
"WORK HORSE" LINEUP of totally-enclosed, fan-cooled Tri-Clad* motors under topping units meet rigid requirements for continuous processing and safety. Cast-iron frame construction helps protect punchings, windings, and rotating parts from dusts, moisture, and hazardous atmospheres. Each motor has a matching explosion-proof push-button station.

*Registered Trade-mark of General Electric Company

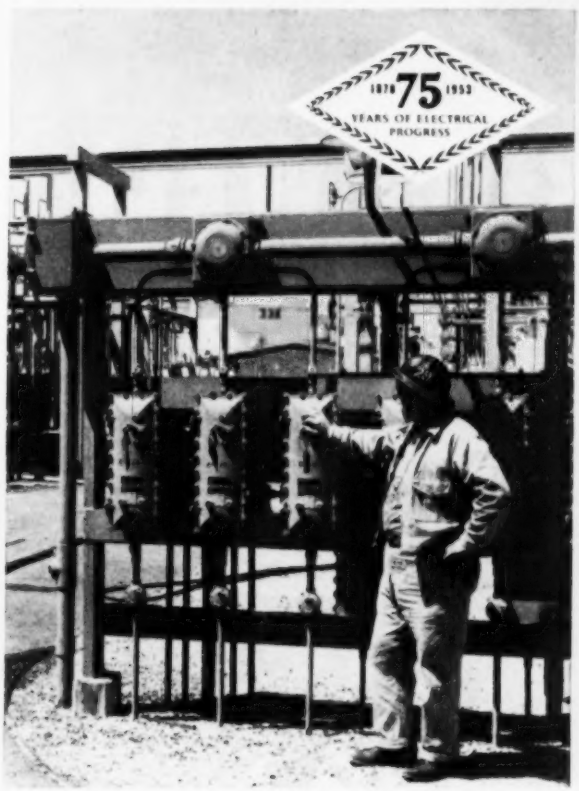
System-planned electric equipment



COMPACT, OUTDOOR METAL-CLAD SWITCHGEAR in foreground is the main distributing point of power to Union Oil's Wilmington refinery. Providing primary circuit protection, these compact G-E units are factory-assembled and shipped ready to install. They're simple to operate and maintain because of a fast, vertical-lift system of breaker removal.



TOTALLY-ENCLOSED G-E MOTORS are designed for corrosive and hazardous refinery locations—like these two Tri-Clad units driving transfer pumps outside pumphouse No. 1.



EXPLOSION-PROOF motor starters have cast-alloy enclosures, helps protect against hazards. They are centralized on one rack for easy accessibility and a better distribution system.

helps keep throughput high at Union

CENTRALIZED G-E LIMITAMP CONTROL, located in a non-hazardous area, starts and protects motors driving refinery equipment.

Two new topping units at Union Oil's Wilmington refinery kept on-stream by G-E power and drive equipment

Recently, the Union Oil Company wound up a $27,000,000 expansion program at their Wilmington, Calif. refinery by putting two new 20,000 bbl.-per-day topping units and the nation's largest vacuum flasher into action.

To help maintain this output on a continuous basis, Union Oil and General Electric engineers co-ordinated all drive and power distribution equipment—"system-planned" it—to the plant's specific processing needs.

G-E application engineers, experienced in refinery practices, are ready to assist you and your consultants in planning an efficient electrical system.

TO HELP CUT YOUR POWER DISTRIBUTION COSTS be sure to see the new full-color sound slidefilm, "The Vital Link." It's another G-E "More Power to America" program. Ask your G-E apparatus sales representative to arrange a showing. General Electric Company, Schenectady 5, New York. 661-42

Engineered Electrical Systems for Petroleum Refineries

GENERAL ELECTRIC

ROCKWELL LUBRICANTS IN TUBES

Already A Success!

GUN LUBRICANT TUBE
Available in boxes of six

Demonstrating convenience of filling a lubricant gun with the Rockwell gun tube.

BULK LUBRICANT TUBE

Available in boxes of four or sixty

Are You Using Them?

LUBRICANT TUBE KEY

Supplied with each lubricant tube

The new Rockwell lubricant tubes for Nordstrom valves were announced just last March, but already our customers have discovered that Rockwell lubricant tubes are the simplest, cleanest and most economical method of valve lubrication ever devised.

For Nordstrom valves equipped with lubricant screws, just insert the tube spout in the valve shank and turn key until lubricant chamber is filled. There's no chance for dirt or grit to contaminate the lubricant.

If you lubricate Nordstrom valves by lubricant gun, specify the Rockwell gun tube. Insert it in your gun and turn key until all lubricant has been emptied into the barrel, It's easy and quick.

If you haven't tried this cleaner, more efficient method of valve lubrication, call your Nordstrom representative or supply store. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

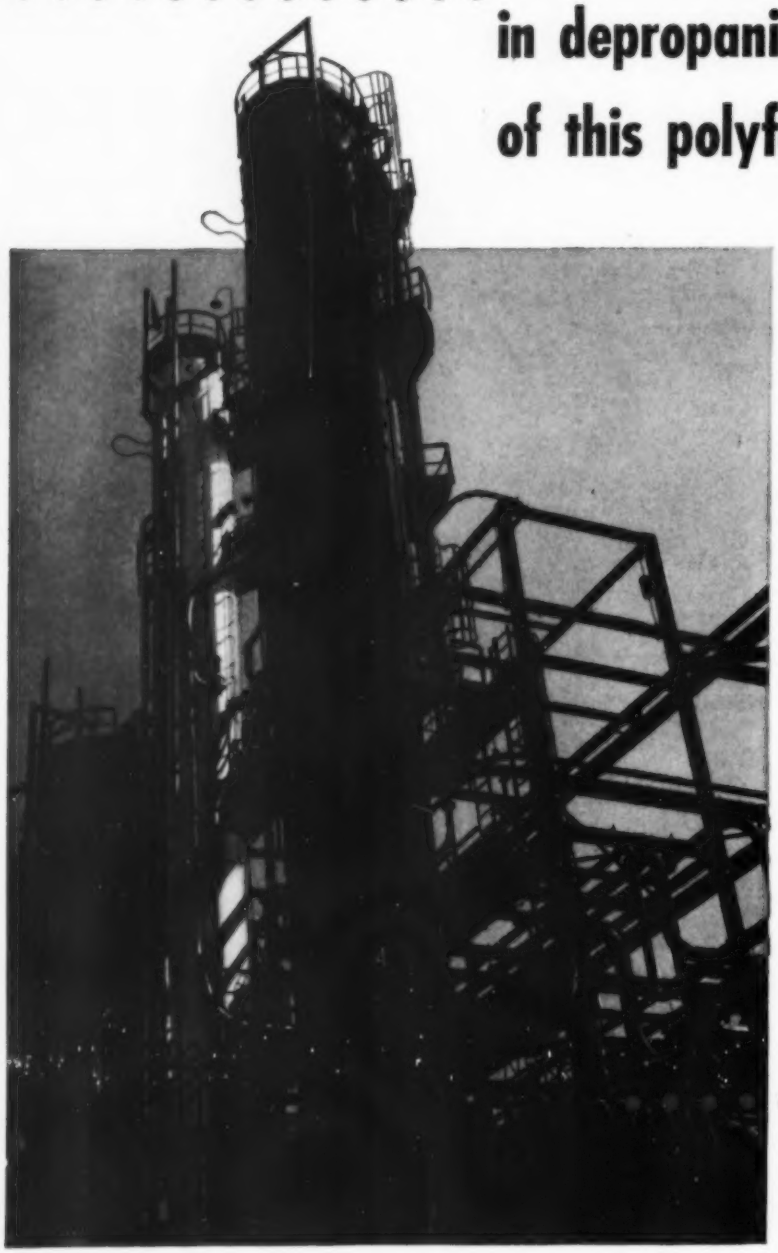
Maintenance man demonstrating ease of lubricating a Nordstrom valve with the Rockwell lubricant tube. One tube fits all sizes and types of Nordstrom valves.

ROCKWELL Built Nordstrom Valves

Lubricant-Sealed for Positive Shut-Off

Another Rockwell Product

Stainless Steel cuts tray plate cleaning in depropanizing tower of this polyform unit



HERE'S an example of the way Stainless Steel's corrosion resistance can stretch out the intervals between cleaning when used in refinery equipment.

Stainless Steel is now being used in the perforated tray plates in the depropanizing tower of the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., refinery. The material formerly used for this purpose reacted with corrosive agents in the gas and the $^{3}/_{32}$" or $^{7}/_{64}$" perforations in the tray were plugged up after two to three months' use.

Then Stainless Steel was given the job. It has greater resistance to corrosion and, consequently, the intervals between cleanings are substantially longer.

Corrosion resistance is only one of the characteristics of Stainless that make it so suitable for refinery use. It is strong, its surface is dense and durable and it performs well in elevated temperature service. When you put all these advantages together, you can see why it is the most effective weapon against refinery down time.

For finest performance from Stainless equipment, always be sure that your equipment fabricator uses perfected, service-tested U·S·S Stainless Steel.

Depropanizing tower in the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., plant. Stainless Steel, used in the perforated trays, has helped to lengthen the intervals between cleanings.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

3-1612

UNITED STATES STEEL

Long range, solid cone of Rockwood WaterFOG snuffs out fire.

"Little Mo" knocks 'em down

He *likes* to go to blazes.

"Little Mo" — a small fire truck that's packed to the hilt with Rockwood fire-fighting equipment — streaks to fires, knocks 'em down and quenches them in seconds. Can be operated by one man, if necessary!

In the test above, fuel in a pit under the tank cars was set on fire — and more fuel poured on top of the cars from pipes. This, too, was ignited and the blaze given a minute's start. In rushed "Little Mo" — and out went the fire in 45 seconds, choked off by Rockwood WaterFOG from Rockwood's Remote Manual Control Turret. What's more, 10 inches of water still remained in "Little Mo's" 200-gallon booster tank, after the fire was out.

It's Loaded! "Little Mo's" equipment includes: 4 stage centrifugal pump with electric primer, 200-gallon booster tank, Rockwood Dual Suction Proportioning System for FOAM and "Wet", Rockwood Remote Manual Control Turret controlled from within cab, Rockwood Ground Sweep Nozzles, Rockwood Remote Control Ball Valves, 2 Hannay reels with 200 feet of high pressure hose with new Rockwood High Pressure Handline Nozzle on each reel.

Thanks to Rockwood portable fire-fighting equipment, even a small truck like "Little Mo" can battle fires with powerful efficiency. The Turret Nozzle, alone, discharges solid water stream, WaterFOG, FogFOAM, solid FOAM, "Wet" solid water, and "Wet" WaterFOG! Rockwood engineers water to cut fire losses.

Leading manufacturers of fire trucks will install Rockwood Fire Fighting Products at your request.

ROCKWOOD SPRINKLER COMPANY

ROCKWOOD *Engineers Water . . . to Cut Fire Losses*

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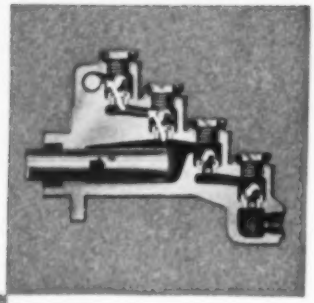
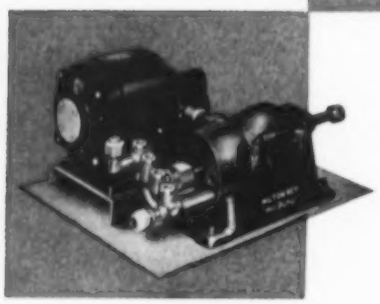


——the discharge stroke of the Milton Roy Controlled Volume Pump. Forward thrust of plunger lifts discharge double ball-checks and displaces metered quantity of liquid. Suction ball-checks are positively seated.

Sloping passages and absence of pockets assure discharge of entrained air, to maintain high and reproducible volumetric efficiency.



Fifty Per Cent Time Savings with this Milton Roy Pump

CONTROLLED VOLUME PUMPING

INSTRUMENTATION

PROCESS CONTROL SYSTEMS

BLENDING AND FORMULATING

On The Job in an Eastern manufacturing plant, this Milton Roy "miniPump" replaced a costly hand process, wherein *one tenth of a milliliter* of liquid was added to open cells on each stroke of the pump. The switch to automatic continuous injection with this pump cut production time in half, gave much greater accuracy.

Such efficiency in the precise metering of minute quantities of any clear liquid is merely one reason why "miniPump" is so widely used in industry. This pump has application in laboratories . . . in pilot plants . . . for full-scale production operations . . . in instrumentation, continuous processing. As air-powered or motor-driven units, they operate within the capacity range of 3 to 3,200 milliliters per *hour*, against pressures to 1,000 pounds per square inch. Accuracy is maintained within 1%.

This precision instrument is the miniature member of the family of Milton Roy Controlled Volume Pumps which range in capacity up to 45 gallons per minute, against pressures up to 25,000 pounds per square inch. They are available as single or multiple units, or as component parts of complete chemical feed and control systems.

Bulletin No. 653 *describes "miniPump", its design, construction, uses. Write* ***today*** *for your* ***free*** *copy.*

Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

MILTON Roy COMPANY

Manufacturing Engineers 1313 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY — AUGUST 1953

NOTES ON

OXO PROCESS

Although the OXO process, because of its relatively recent appearance in the chemical industry, has frequently taken technical headlines, the various steps which precede this reaction are just as fundamental to the economic success of this new method for making alcohols.

* * *

Typical of OXO processing is a plant now underway in the U. S. in which a C_7 cut is reacted with synthesis gas to make aldehyde which is then hydrogenated to iso-octyl alcohol.

* * *

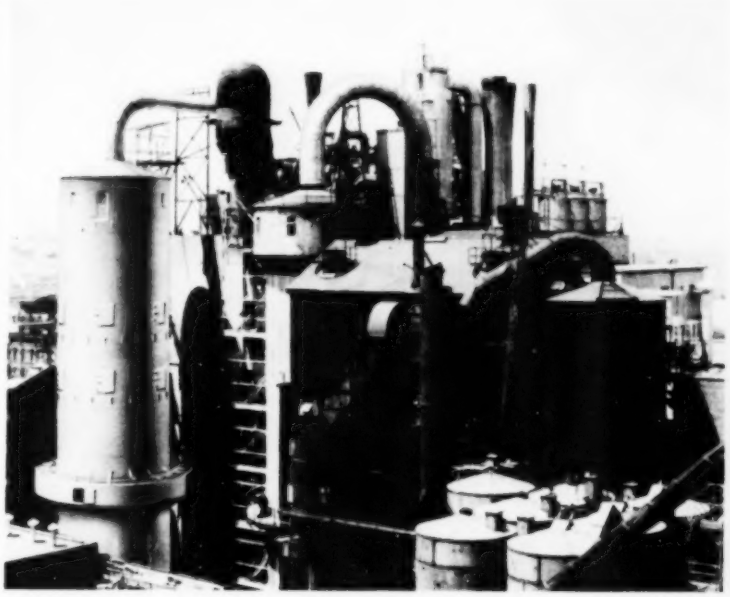
The three major feed preparation steps were all designed by Kellogg which is erecting the entire plant. These are (1) preparation of synthesis gas, (2) purification of hydrogen, and (3) close fractionation and high recovery of a C_7 heart cut from polymer gasoline.

* * *

In designing the synthesis gas reformer, particular attention was paid to flexibility in view of the novelty of the OXO process so that the composition of the gas might be varied to explore the effect of different mixtures on the yield of alcohol.

* * *

One of the novel features of the overall integration of the plant is a unique combination furnace for the production of hydrogen and synthesis gas. By providing the heating requirements for both these processes from one source, a saving in furnace cost of about 40% is effected.



Proper powder handling takes sneeze out of kitchen

One problem in the manufacture of detergents for home use lies in particle breakage. It causes sneezing in the kitchen as the housewife inadvertently inhales microscopic dust when she shakes out the "soap."

This domestic annoyance had major chemical engineering repercussions at the manufacturing level—and it brought into play a design concept usually associated with the oil refining industry.

The majority of particle breakage has occurred in the handling of huge volumes of powdered detergent following the drying step. When engineering this particular section of a new detergent plant—which is now in production—Kellogg utilized its specific experience acquired in designing scores of Fluid catalyst systems in the oil refining and chemical industries, and designed a new type of carrier system.

In essence, the unique system which involves large volumes of detergent particles cushioned on air, is a by-product of fluid processing. It gently and rapidly transports the dried detergent to the top of a six-story building for further processing with minimum production of "sneezing powder."

Montecatini Urea Process Saves on Utilities Costs

One of the major economic advantages of the Montecatini urea process lies in very significant utilities savings. These are brought about by maintaining the recycle of carbamate, ammonia and carbon dioxide in a liquid state rather than separating these components and then recompressing before charging them to the reactor.

Thus, in comparison with other urea processes on the market, it's a case of pumps vs. compressors—at a saving in utilities computed to be about 25%.

(SEE REVERSE SIDE)

CHEMICAL PROCESS NEWS

CONTINUED FROM PRECEDING PAGE

Polyethylene Plant Now in Engineering

Engineering is well underway on a large polyethylene plant Kellogg is soon to erect in Tuscola, Ill., for the National Petrochemical Corporation.

When complete, at a cost of several million dollars it will produce 50 million pounds annually of this important basic material. The process is licensed by Imperial Chemical Industries, Ltd., of England.

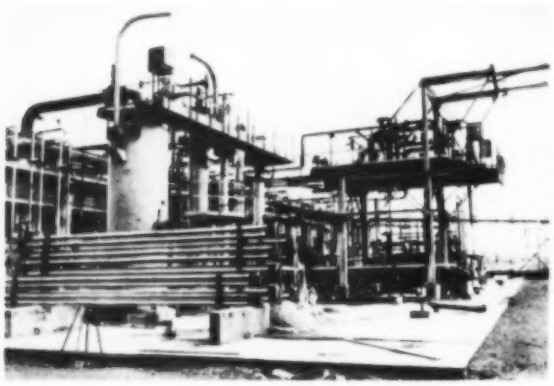
To a large extent, Kellogg's familiarity with the polyethylene process stemmed from another recent contract. This one involved the processing and erection of an ultra-high purity ethylene plant for ICI, the product from which is charged directly to a polyethylene plant.

In the work concerned with the design and construction of this plant (it produces 99.94% pure ethylene) Kellogg developed a close association with ICI which led to its present familiarity with the problems of manufacturing polyethylene.

High Pressure Ammonia Plant Nearly Ready

Insulating, weather-proofing and painting stage has been reached in the erection of this ammonia plant on the West Coast. It is well over 75% complete.

When on stream it will employ not only Kellogg's unique reactor for the synthesis step but also an unusual design in the reformer which avails itself of the high pressure of natural gas. Thus 25 to 35% in compressor cost is eliminated at no loss to the effectiveness of the reforming operation.



Solexol® Marine Oil Unit for Norway

Part of a two-phased program for the processing of fish oils, this Solexol unit (above) is well underway for De-No-Fa in Norway. It employs propane to effect fractionation and decolorization in a process perfected in the Kellogg laboratories. It fractionates the oils into varied high and low-iodine grades which nominally are used in the production of margarine.

However, when desired, the unit may also be used for the production of a clean feed stock for a fat splitter (right above) Kellogg is erecting simultaneously. Typical of two units MWK has designed and erected in the United States, the new plant has strategic importance for Norway in that it will double the production of domestic glycerine.

Typical Current Kellogg Chemical Plant Contracts

- ★ Phenol-from-cumene (2)
- ★ Iso-octyl-alcohol
- ★ Ethylene
- ★ Polyethylene
- ★ Ammonia
- ★ Phthalic Anhydride (2)
- ★ Glyceride Purification
- ★ Liquid Fuel and Chemicals Synthesis from Coal

For further information, technical data, etc., relating to chemical or petrochemical processing, write

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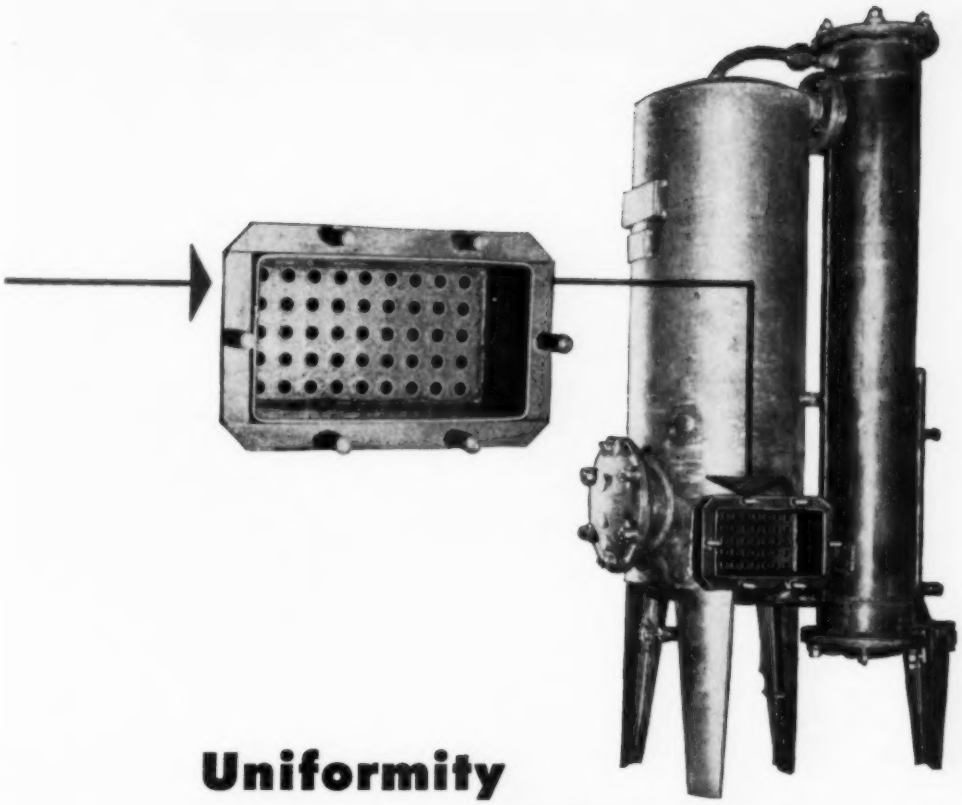

Uniformity helps cut tubing costs

Butler Mfg. Company of Kansas City was having trouble installing heat exchanger tubes in dry cleaning solvent recovery stills. One headache was tube concentricity. Another was the wide variation of both inside and outside diameter dimensions. Still another was the variation of physical properties.

Switching to Republic ELECTRUNITE Pressure Tubes solved the problem. Tubes are uniformly round. Because wall thickness is uniform, inside and outside diameter are concentric.

Results: Tubes slide in quickly. They expand easily with less danger of over or under-rolling. And because they are fully annealed, uniformly ductile ELECTRUNITE Pressure Tubes roll-in and bead fast . . . make tight joints . . . save time.

On your next job . . . tubing or re-tubing . . . boiler, condenser or heat exchanger . . . it will pay you to specify ELECTRUNITE Pressure Tubes. Available in carbon or Enduro Stainless Steel analyses. Write for Bulletin CEC-53.

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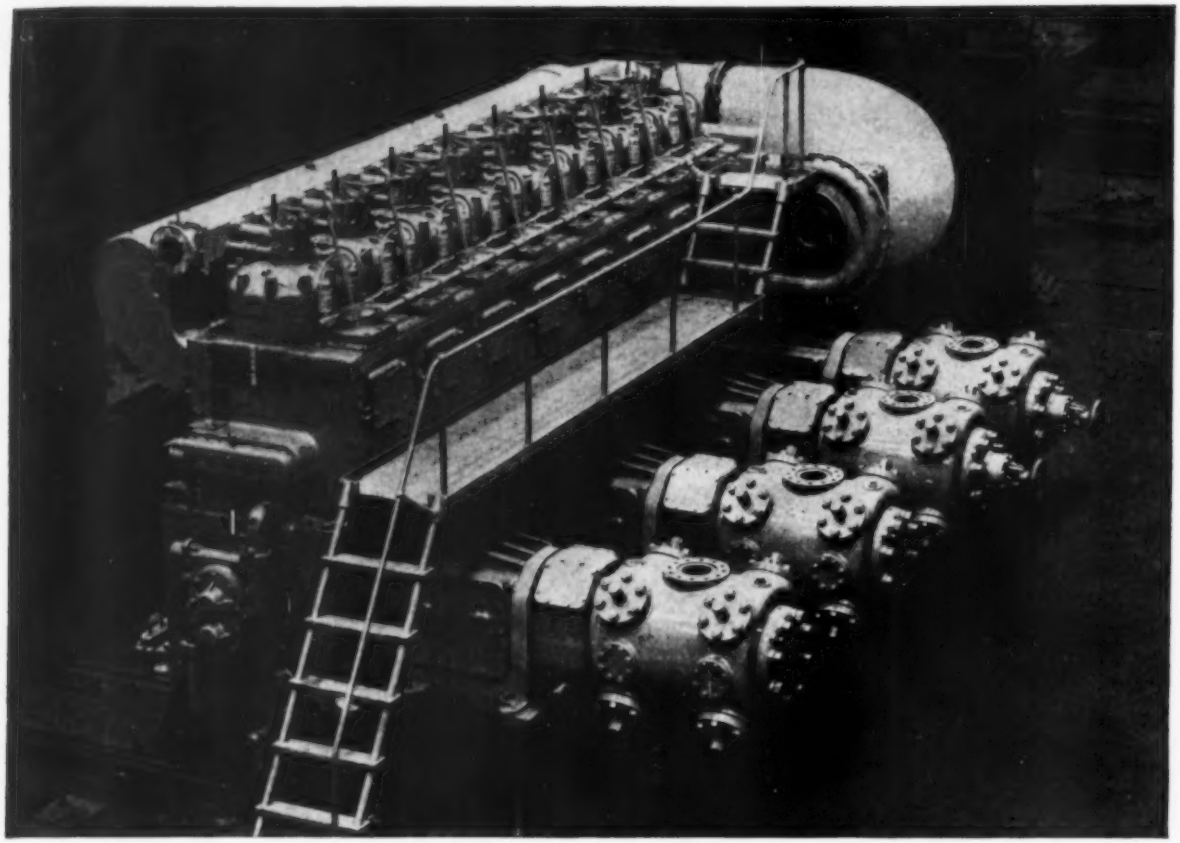
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

ELECTRUNITE . . . THE ORIGINAL ELECTRIC WELDED BOILER TUBE



Clark 2-Cycle Turbocharged "Right Angle" Heralded As Most Significant Development In Compressor History

Revolutionary changes in gas-engine-driven compressor design set new records for power (50% increase), fuel economy (10-15% decrease) and cooling water load (25% decrease)

THE recently developed Clark 2-Cycle Turbocharged Right Angle Compressor has set new, industry-wide standards for power and operating economies, reports Clark Bros. Co., Olean, N. Y.

Climaxing an intensive 7-year Clark development program, the availability today of this completely new, turbocharged compressor design provides the realistic and ready answer to increasing cost of gas, inadequate cooling water supply in certain areas and the need for more powerful, more compact units. Clark engineers list the following points in support of these claims:

50% More Power

Fifty percent (50%) more power is delivered than by any previously built non-turbocharged unit of comparable bore and stroke (without any encroachment on overload carrying ability). The stepped-up power output means reduced building, foundation, piping and maintenance costs as well as decreased operating personnel.

10-15% Less Fuel Consumed

Conservatively rated, the new Clark unit is guaranteed to burn 10 to 15% less fuel than the best non-turbocharged, high compression, gas-engine-driven compressor previously built.

25% Less Cooling Water Load

Cooling water requirements per bhp are twenty-five percent (25%) less than those of the best non-turbocharged, high compression, gas-engine compressor previously built (including scavenging air

(Advertisement)

intercooling duty). This is important not only in arid locations, but means fewer cooling towers, smaller pumps, smaller piping and smaller motors to drive water pumps.

Flat Fuel Consumption Curve

Fuel consumption remains practically constant between seventy percent (70%) of load and maximum load, assuring optimum fuel economy over the entire operating range.

Quiet Operation

Energy, formerly lost in noise, is now harnessed for useful work by the Clark Turbocharger. This, plus a fully insulated exhaust manifold and en bloc construction, make it the quietest, smoothest operating gas-engine-driven compressor ever built. There are no exhaust pulsations.

UNITIZED, MATCHED DESIGN

Both turbocharger and compressor were designed and built by Clark as matching components. The result, say Clark engineers, is a highly efficient, unitized and integrated design.

The Turbocharger

The Clark turbocharger combines many of the design principles of Clark radial inflow turbines, combustion gas turbines and centrifugal compressors.

As applied to the new Clark Compressor, turbocharging is a practical means of converting waste heat into energy. It utilizes the waste heat, velocity and mass flow of the exhaust gases to drive a radial inflow turbine. The turbine, in turn, is integrally connected to a centrifugal compressor impellor which pumps air to scavenge the power cylinders and to furnish air for combustion. No scavenging cylinders are used or required.

At start-up and on light loads, the turbocharger is direct driven through a gear train from the engine crankshaft. Under all other load conditions, the turbocharger operates independently of the engine, its speed automatically conforming to the load placed on the engine.

Because the Clark turbocharger operates at very conservative speeds and temperatures, no critical, scarce materials are required for its construction.

The Compressor

While the gas-engine-driven compressor is an entirely new unit, specially designed to match the characteristics of the new Clark turbocharger, it retains many of the basic Clark "Angle" design features. Clark engineers describe it as the most rugged compressor ever built, "with a very conservative BMEP rating for a unit of its proportions."

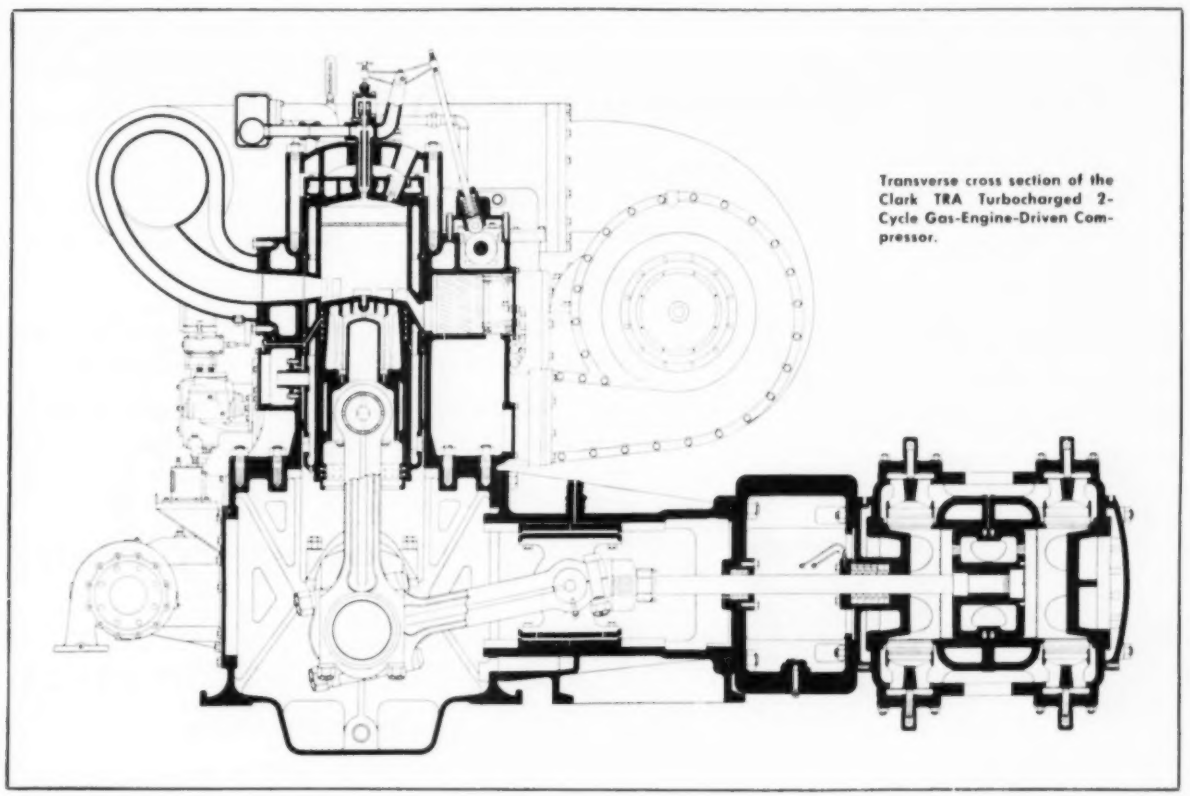
Following a long established Clark practice, the new compressor is an extremely compact, yet highly accessible 2-cycle, in-line design. It occupies considerably less space per bhp than non-turbo-charged units, because of its increased power output. Featured are: Cylinder block construction with removable power cylinder liners; full precision bearings; one-piece forged steel crankshaft; oil-cooled power piston heads and skirts; heavy, forged steel connecting rods; fully insulated, streamlined exhaust system.

MODELS

The Clark Model TRA-8, illustrated, has eight vertical in-line power cylinders of 14″ bore and 14″ stroke, developing 1320 bhp. Other size turbocharged units also are available.

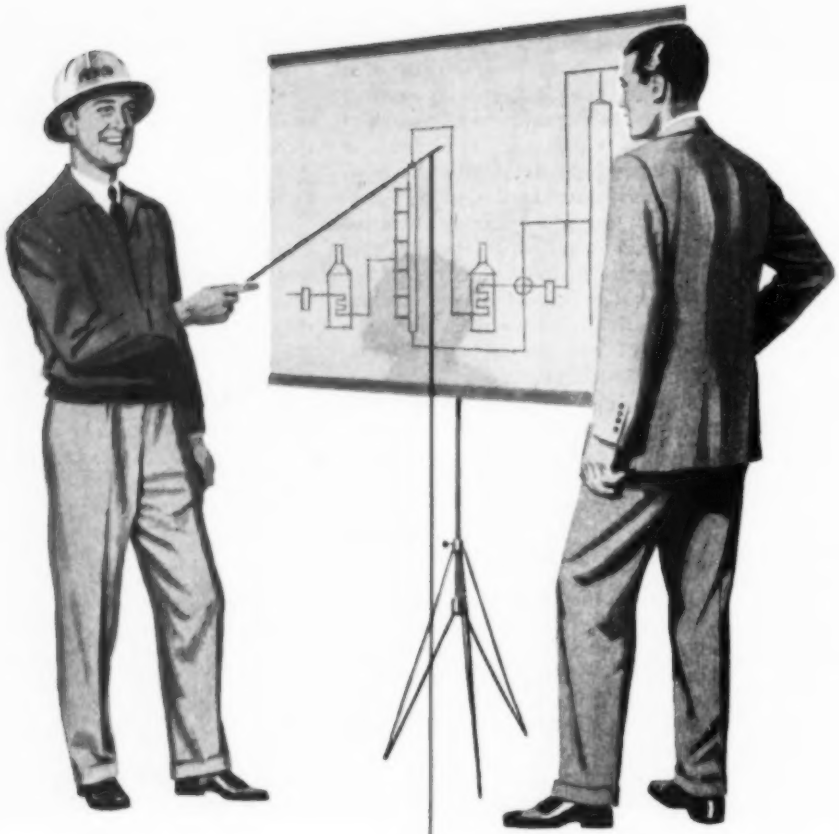
Bulletin 130, with complete information on the Clark 2-Cycle Turbocharged Gas-Engine-Driven Compressor is obtainable from Clark Bros. Co., Division of Dresser Operations, Inc., Olean, N. Y.

Clark manufactures a complete line of heavy duty compressors: motor driven; gas, steam and Diesel engine driven; centrifugal and axial flow.



Transverse cross section of the Clark TRA Turbocharged 2-Cycle Gas-Engine-Driven Compressor.

(Advertisement)



Process Improvements with PERCO*

In recommending improved Perco processes, our foremost concern is to *upgrade your throughput efficiently—at an economical cost per barrel.*

If you have a processing problem—if your profit picture is not all it should be—consult Perco. A Perco engineer will be glad to discuss the selection and adaptation of specific Perco processes for your particular needs.

Over 130 installations licensed by Perco throughout the United States, Canada and Latin America prove the wide application of Perco processes to current refining problems.

Now is the time to upgrade your throughput.

Write Perco today for full information.

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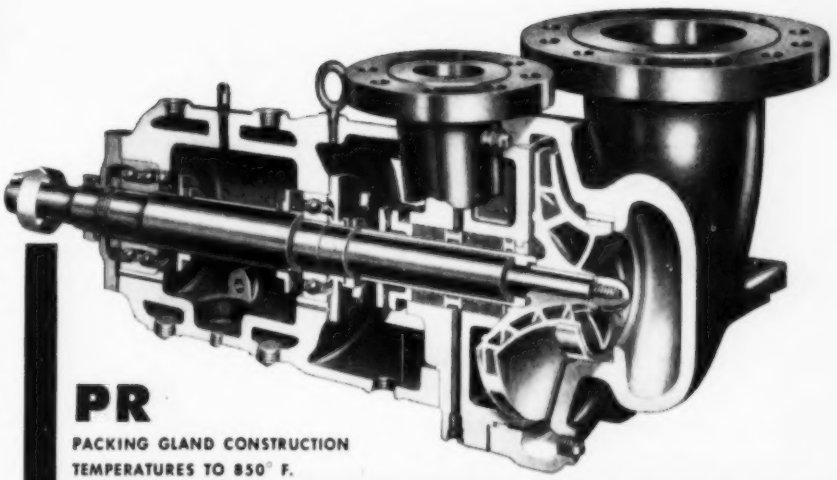
*A SERVICE MARK

Bartlesville, Oklahoma

BUY PUMPS OUT OF STOCK FOR "CUSTOM" PUMP JOBS

These rugged, center-line-mount pumps are available in a complete range of sizes, many of which are available from stock. Peerless application experience shows that up to 70% of refinery hot oil pump requirements can be met by these two Peerless pump designs. In addition to the choice of either packing gland or mechanical shaft seal construction, features common to both pumps include: use of spacer type coupling to permit liquid and disassembly without disturbing piping; oversize shafts; oil lubricated, heavy duty, radial and thrust bearings; spot electric welded case and impeller-wear rings; end or top suction design; extra low NPSH requirements. Mail coupon for descriptive bulletin today.



PR

PACKING GLAND CONSTRUCTION
TEMPERATURES TO 850° F.

2 designs

TO CHOOSE FROM...

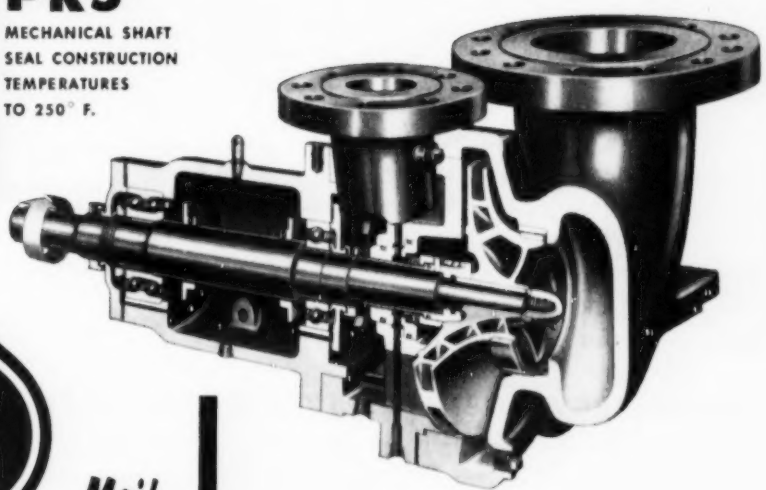
70% OF ALL YOUR HOT OIL PUMPING REQUIREMENTS CAN BE SUCCESSFULLY MET WITH THESE STANDARD PEERLESS PUMPS

CHARACTERISTICS at a glance

Capacities	up to 1000 gpm
Operating Heads	up to 625 feet
Case Pressures	up to 400 psig
Drives	horizontal electric motor is standard; other types as required
Material of Construction	liquid end can be of any material suitable to intended service

PRS

MECHANICAL SHAFT SEAL CONSTRUCTION
TEMPERATURES TO 250° F.



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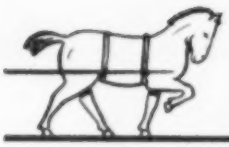


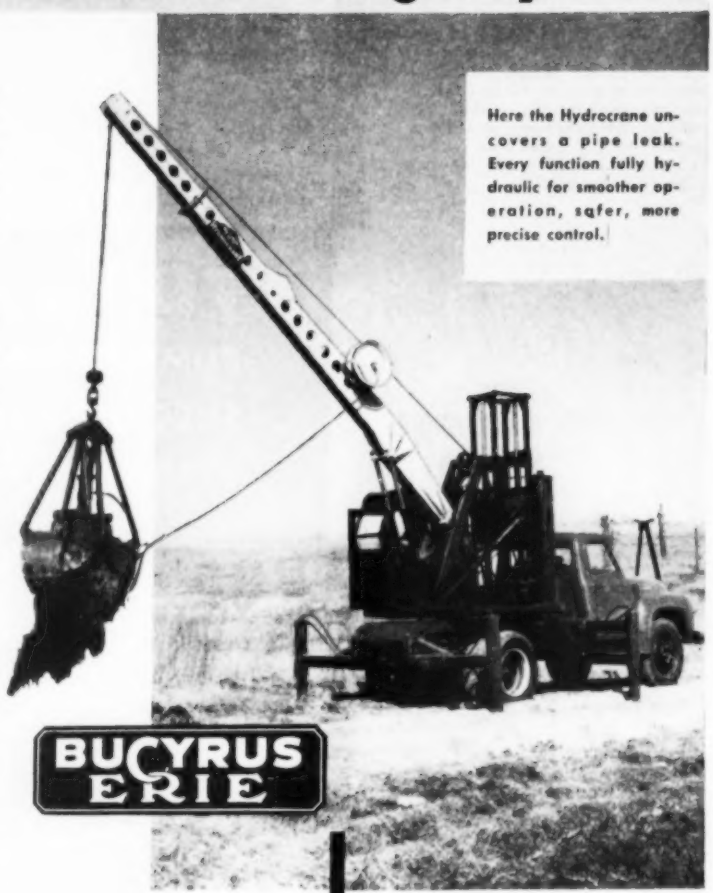
WORKHORSE on Routine Jobs

RACEHORSE on Emergency Calls

The versatile Bucyrus-Erie Hydrocrane is a proved money saver on dozens of day-in day-out refinery lifting, moving and material handling jobs. It does them quickly, smoothly, economically.

AND IN AN EMERGENCY IT'S A REAL "LIFESAVER". LOOK: On hurry-up calls, operator can wheel the compact Hydrocrane through traffic with the ease of a light truck. Telescoping boom fits snugly over cab instead of bobbing out behind. On open highways he can step 'er up to 50 mph — save precious minutes that often save dollars.

As soon as it reaches the job site, the Hydrocrane whips into action. Outriggers extend hydraulically in seconds—providing a firm, solid working base. No time out for cribbing or blocking. In addition its short tail swing and maneuverability make it the choice for close quarter work.



Here the Hydrocrane uncovers a pipe leak. Every function fully hydraulic for smoother operation, safer, more precise control.

QUICK CONVERTIBILITY ANOTHER ADVANTAGE

The Hydrocrane has actually been converted to Hydrohoe front end by one man in less than an hour! Even when time is short such conversion speed makes it practical to change booms.

Join the growing list of enthusiastic Hydrocrane users. See your Bucyrus-Erie Hydrocrane distributor for a demonstration on your job. BH53

Busy As A Bee—

This Free Book Tells Why!

Pictures in this handsome booklet tell the story of 82 Hydrocrane and Hydrohoe applications. Write for your copy now.

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CHEMICO
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AMMONIA PLANTS

...produce one fourth of the world's supply of

ANHYDROUS AMMONIA

Figures show that approximately one out of every four tons of anhydrous ammonia produced in the United States—in fact, produced in the world—comes from Chemico-N.E.C. Process plants. This impressive record finds its explanation in the following five simple statements of fact.

FIRST, Chemico plants operate at 350 atmospheres, the optimum pressure for maximum economy, simplicity of design and safety in operation.

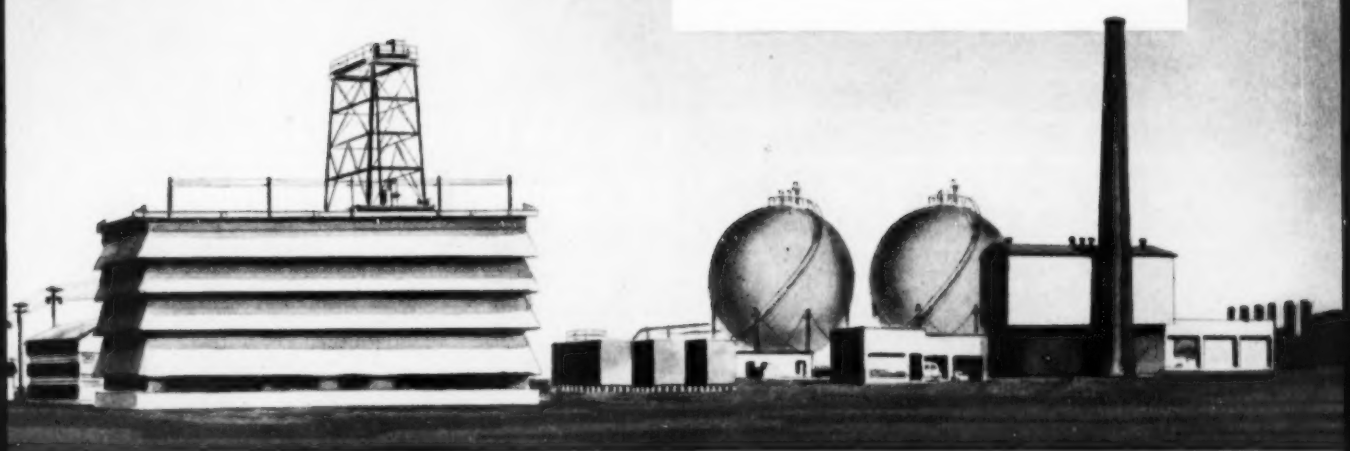
SECOND, Chemico's ammonia converter design assures perfect temperature control with resulting high conversion, long catalyst life and uninterrupted operation over long periods of time.

THIRD, modern design and complete instrumentation of Chemico's plants reduce manpower requirements, maintenance and operating costs.

FOURTH, almost thirty years of experience in this specialized field provides the background that assures the client of complete satisfaction when purchasing ammonia plants of Chemico design.

FIFTH, Chemico's interest and service extend beyond the final construction and initial operation stage. Consultation services and assistance are always available for the benefit of clients.

If you're thinking of making synthetic ammonia, or expanding present capacities, it will pay you to investigate all the advantages Chemico offers. Write today for Chemico Bulletin A-101.



CHEMICAL CONSTRUCTION CORPORATION

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Chemico plants are profitable investments

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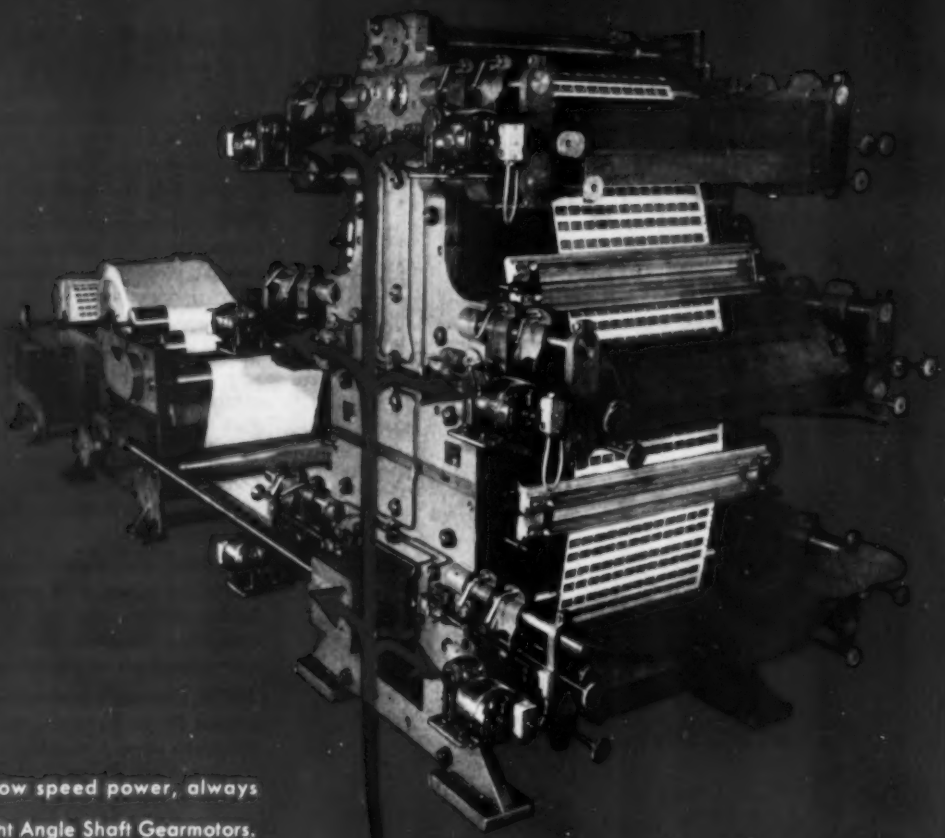

When you must have slow speed power, always consider first MASTER Right Angle Shaft Gearmotors. They're very compact . . . low in cost . . . safe . . . and so easy to use.

And nowhere else can you get anywhere near the wide range of selection that you have in MASTER Right Angle Gearmotors. They're available in sizes ⅛ to 25 Horsepower for all electrical specifications and in splash-proof, enclosed or explosion-proof construction. Gear reduction ranges up to 430 to 1 with the countershaft in either horizontal or vertical positions. In addition these gearmotors can be supplied with integrally built electric brakes . . . three types of variable speed units . . . and with fluid drive units for cushioned power.

Try them . . . you'll find they're the horsesense way to get slow-speed horsepower.

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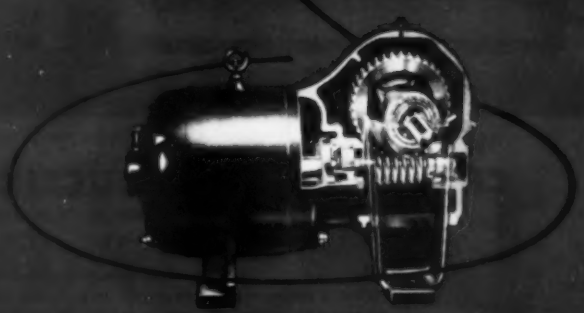
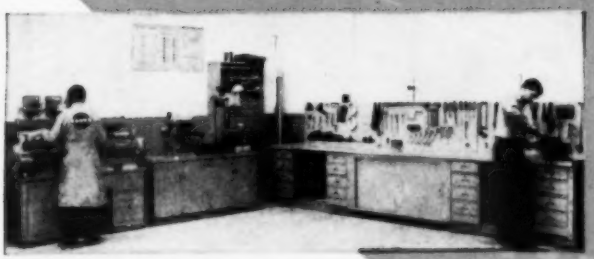
DAYTON 1, OHIO

you can't beat them for compact slo-speed power

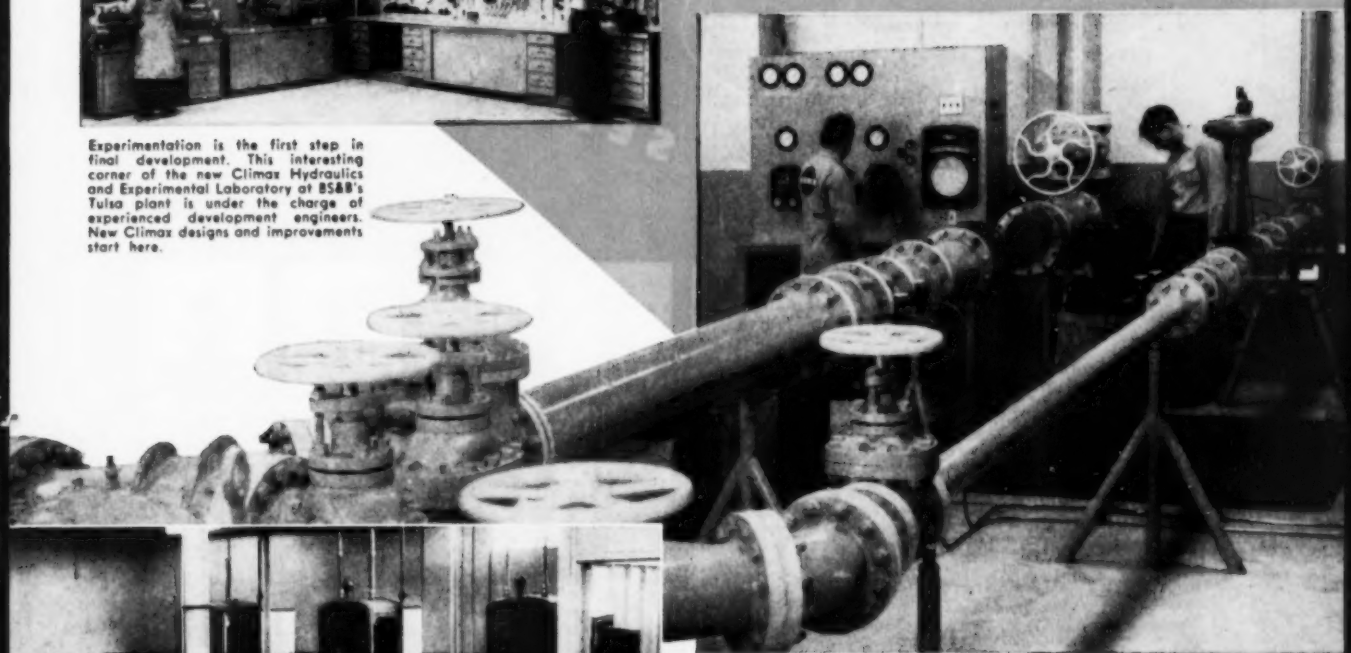


Testing the performance on which BS&B reputation has been built:

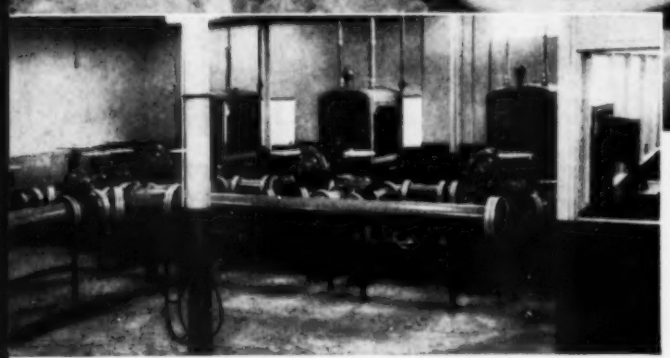
Pre-Proving CLIMAX CONTROLS to Insure On-The-Job Efficiency



Experimentation is the first step in final development. This interesting corner of the new Climax Hydraulics and Experimental Laboratory at BS&B's Tulsa plant is under the charge of experienced development engineers. New Climax designs and improvements start here.



The finished control on the "torture rack." Meter runs flow test the valves up through 10". Strain gauge equipment analyzes forces and stress under performance. Control panel in background regulates engines driving the pumps and registers flow data for calculation.



Pump manifolding for the 3 engine-driven pumps which will deliver up to 4500 gallons per minute at a 100 lb. discharge for high volume tests. Pumps can also be manifolded for series operation, in which case 300 lbs. of water at 1500 gallons per minute can be delivered.

There's no question about a Climax Control giving the satisfactory service for which it is designed. That performance is tested and proven before the control goes into the field . . . checked for minimum and maximum capacity. Flow, flow effects, valve characteristics and strain results are all evaluated by experienced engineers. Through the new BS&B Climax Control Hydraulics laboratory come a continuing series of answers to the more efficient, safe and profitable application of automatic controls. One test suggests another, one application is adapted to a similar problem. The net result: Through research, better engineering, and accurate pre-testing, comes a more efficient Climax Control.

New Climax Controls Hydraulic and Experimental Laboratory

See our exhibit at the Eighth National Instrument Exhibit, September 21 to 25, Sherman Hotel, Chicago, Booths 148 to 150.

BLACK, SIVALLS & BRYSON, INC.

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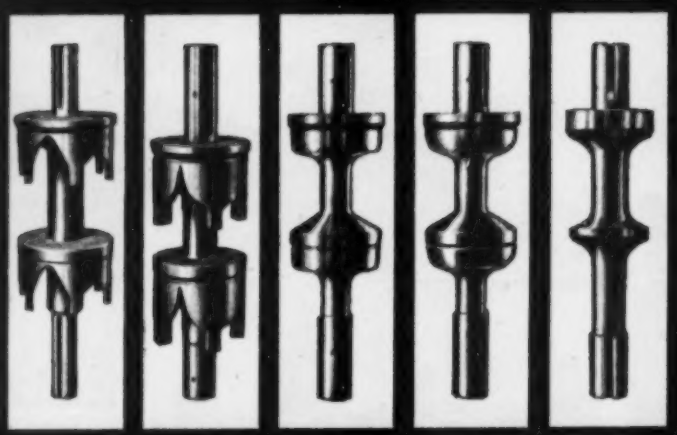
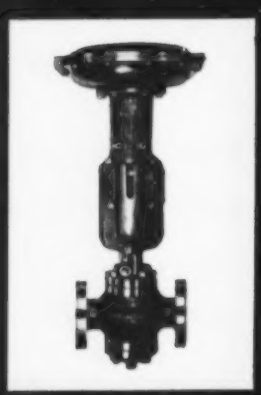
CLIMAX BS&B CONTROLS OUR 60TH YEAR

WIDE SELECTION . . .



for any valve application



Discs for the Honeywell Series 700 Valve include single and double-seated V-ported and contoured types, each with either linear or equal-percentage characteristics, plus a flat disc for on-off control . . . all ground and polished . . . all designed to retain characteristics under severe service. The Honeywell Series 700 Valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* 1907 Windrim Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
VALVE PRODUCTS

H HONEYWELL

First in Controls

5 reasons why PETRECO is your best buy in desalting

1. HIGH QUALITY EQUIPMENT

Petreco pioneered electric desalting, and has spent many years experimenting, developing and perfecting the best desalting process available. Just compare a Petreco installation with any other! Note the spherical treating vessel; it utilizes minimum ground space and yields higher treating capacities. Petreco transformers are specially designed for the heavy demands of desalting service. Petreco's dual electrode system, with independent transformers, gives greater efficiency and dependability. Petreco's specially designed emulsifying equipment and distributor yield maximum treating efficiency with smoothest possible operation. *In short*, you can't get better desalting equipment than that furnished by Petreco. Make your own comparison!

2. ENGINEERING

In addition to the engineering design that goes into every Petreco desalting unit, the Petreco engineering staff cooperates with the refiner's construction staff or contractor all during the desalter installation. This means that there is an experienced Petreco construction engineer "on the job" during construction, to make sure that your desalter is installed according to most modern practice and with no delay.

3. SERVICE

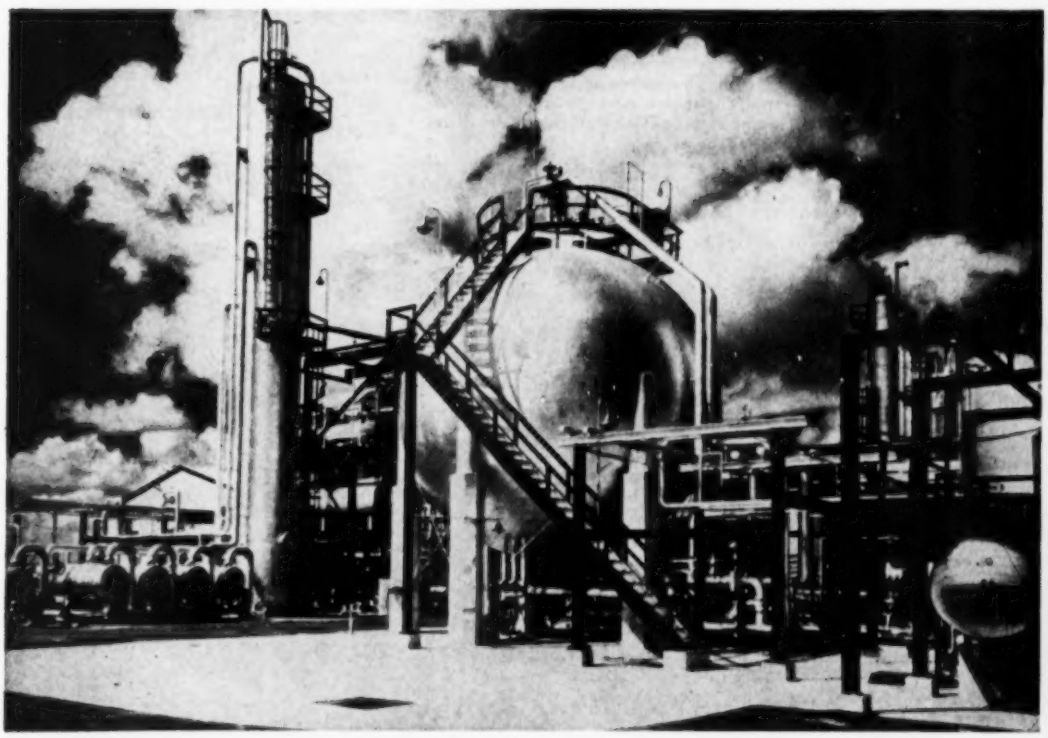
When your Petreco desalter is completed, Petreco desalting engineers make sure that the plant goes on-stream without a hitch by making the adjustments necessary to insure top desalting performance. They instruct refinery personnel in the proper operating methods. Then, with the plant operating smoothly, the Petreco district service engineer takes over the responsibility. Petreco service engineers are trained experts, located wherever Petreco desalters are in use. They are available on twenty-four hour call in case of emergencies.

4. RESPONSIBILITY

The Petreco service engineering staff is a tangible symbol of responsibility. When your Petreco desalting plant goes on-stream, a Petreco service engineer is assigned. He will make sure it operates at the highest levels of safety and efficiency. Petreco responsibility is your assurance of continuing top performance.

5. ECONOMY

The only cheap thing in a Petreco desalter is the cost. The initial installation cost may seem substantial, but when you balance the expense of installation, etc., against the savings, you'll find that a Petreco desalter is the most profitable unit in your refinery. When it starts paying out in terms of longer uninterrupted runs, with more barrels refined per calendar day, the initial cost becomes negligible.



Complete facts on Petreco desalting are yours for the asking. Just write or call

PETROLITE CORPORATION

PETRECO DIVISION

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PETRECO

PD 53-2

Suppose we put the Dempster-Dumpster System right down in your plant . . . then what?

● *Well First—let's make it clear that we are furnishing you with several sizes of different designs of 26 containers to suit your materials requirements. Then bear in mind that we are delivering you only one truck-mounted Dempster-Dumpster and with your driver this one outfit picks-up, hauls and dumps all containers, about like the one shown above.*

Now, how many conventional trucks are you using for handling rubbish, scrap, raw materials, and what have you?

For several years now, one plant has been doing considerably more work with two Dempster-Dumpsters and two men than they did with five trucks and fifteen men before the Dempster-Dumpster System was installed. You can guess at the approximate savings annually.

A glance at the picture below and you get the whole story of the Dempster-Dumpster System. Never before have you been able to cut bulk materials handling costs so drastically.

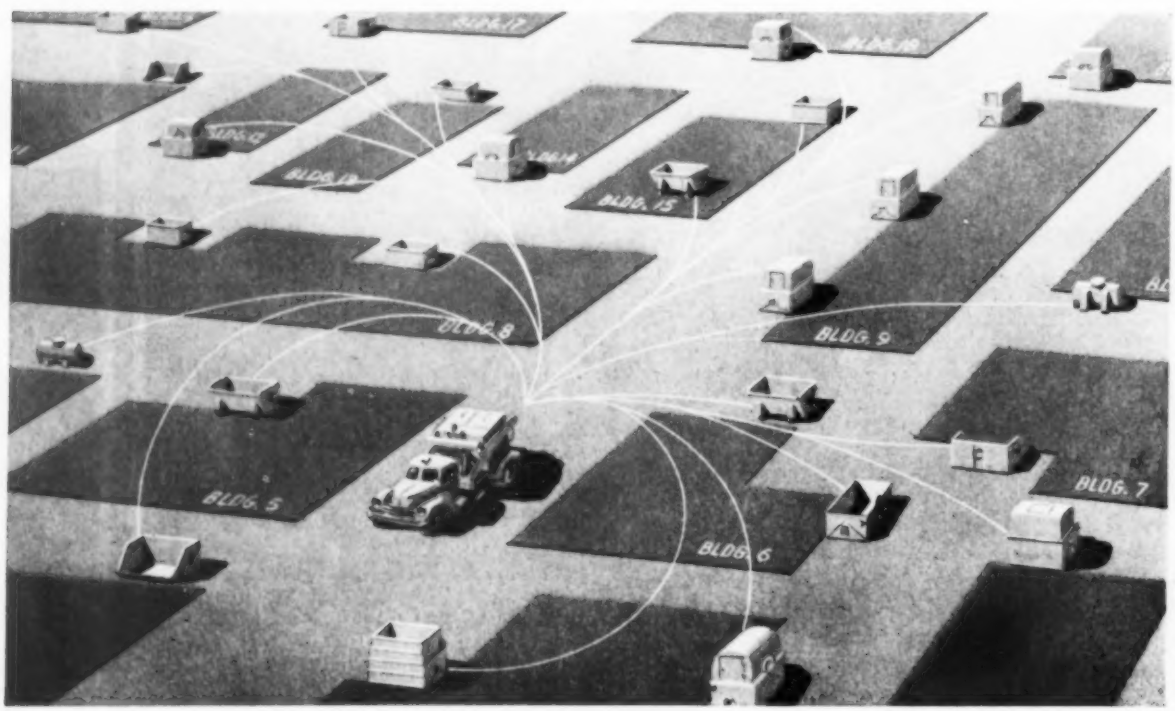
One truck mounted Dempster-Dumpster handles the entire group of 26 Dempster-Dumpster containers. These big, detachable steel containers are like having 26 truck bodies for a single truck.

Any required number of Dempster-Dumpster containers are spotted at convenient materials accumulation points inside and outside your buildings. They range in sizes up to 12 cu. yds.—3 to 4 times the capacity of a regular dump truck. Materials—bulky, light, heavy, solids, rubbish and even liquids—are dumped or placed into these containers.

The truck mounted Dempster-Dumpster makes scheduled rounds, picks up each preloaded container, carries it to the point of disposal, sets it down intact or dumps the materials and returns the container for refilling. The entire operation is hydraulically controlled and handled by your truck driver.

It's as simple as we have described it. The amazing thing is the tremendous savings being made by the Dempster-Dumpster System in hundreds of leading industrial plants over the nation.

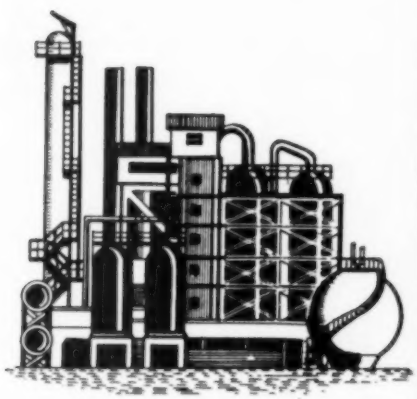
A product of Dempster Brothers, Inc.



DEMPSTER BROTHERS, 583 Dempster Bldg., Knoxville 17, Tennessee

9 REASONS WHY

KONTOL
is widely used in refineries



1. Kontol protects against attack by organic and inorganic acids, brines, hydrogen blistering and hydrogen embrittlement.
2. It is equally effective in the protection of steel, nickel and stainless alloys of steel, monel, brass and admiralty metal.
3. The Kontol protective film is stable and effective at temperatures up to 450°F. (Kontol itself is stable at 550°F. and more.)
4. Kontol has detergent as well as protective properties. In addition to protection against corrosion, Kontol also assures the advantages of operations with cleaner units and cleaner flow systems.
5. Kontol has no adverse effects on the properties of distilled products such as distillation end-point, gum formation, anti-knock rating, ash, etc.
6. Compared with the value of the metals it protects, and the labor costs of replacing them, the cost of Kontol protection is negligible.
7. Kontol is convenient and safe to handle, easy to apply. No gloves, masks, goggles, aprons or extraordinary safety precautions are necessary.
8. Kontol is available in a variety of formulas: oil soluble, oil soluble and water dispersible and water-soluble-oil-insoluble. In these forms, Kontol is suitable for injection into hydrocarbon systems, as well as in systems where the addition of hydrocarbon oils would be harmful.
9. The Tretolite Company's staff of corrosion engineers will assist you in the selection of the appropriate formula and its application to your problem.

A DIVISION OF THE PETROLITE CORPORATION

TRETOLITE COMPANY

Chemicals and services for the petroleum industry

SAINT LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

DEHYDRATING • DESALTING • CORROSION INHIBITING • SCALE PREVENTING

PARAFFIN REMOVING • WATER DE-OILING

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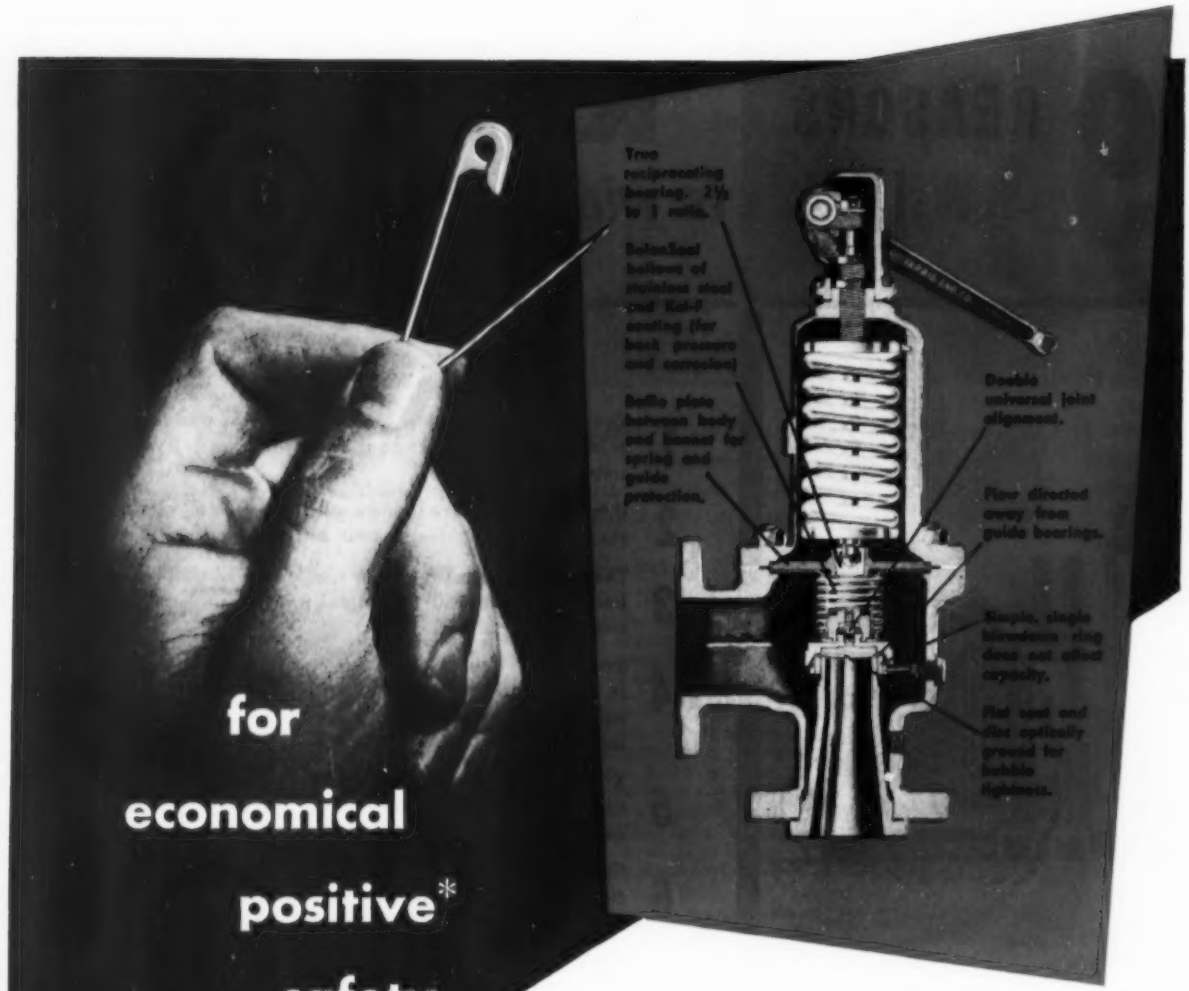

BalanSeal and FarriSeal Safety-Relief Valves

(Pat'd & Pat. Pending)

Farris

ENGINEERING CORPORATION

536 Commercial Avenue

PALISADES PARK, NEW JERSEY

Corrosion and varying back pressure—the two dangerous enemies of positive safety-relief valve operation—are stopped cold by the ingenious construction of Farris valves. Critical working parts are isolated from the lading fluid so that they can't stick, plug or corrode and the special bellows construction nullifies the effect of back-pressure surge. You get positive protection, under all operating conditions. Manufacturing economies offer realistic pricing—and the design permits the use of much smaller discharge piping, at an important saving. So for safety and economy, specify FarriSeal or BalanSeal safety-relief valves. You're never stuck, because *they* never stick!

Technical manual, 51B, a treatment on Back Pressure Piping and Surge characteristics and 76-page catalog is yours for the asking.

*ASME-N.B. APPROVED
(Certified for Capacity)

Affiliates:

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JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT • ROTAMETERS • FLOW INDICATORS • RADIAFIN TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS

HERE'S A PUMP WORTH LOOKING INTO!

and, the best way to do it is to ask for a copy of NEW BULLETIN 17-A

If you want a well engineered, well built, genuinely efficient pump for handling materials ranging from kerosene to asphalt to wax or other materials with viscosity ranges from 30 to 10,000,000 S.S.U. . . . or, if you need a pump to operate within capacities from 1 gph to 1000 gpm, depending on the fluid . . . or a pump built for operating against pressures up to 3500 psi . . . one of the line of Gear Pumps offered by SK can be made to meet your requirements.

Just to *tell* you that these pumps have earned a fine reputation in the Petroleum and Petrochemical industries, as well as many other fields, isn't enough, we know. You want to know the whys and wherefores, and these aren't easy to explain in limited space.

Briefly, however, one of the outstanding contributing factors to the *efficiency* of these pumps lies in the fact that SK engineers can use selected materials—modify design and construction—to fit the application. Or, if the job warrants it, SK engineers will design a new model to give you what you want.

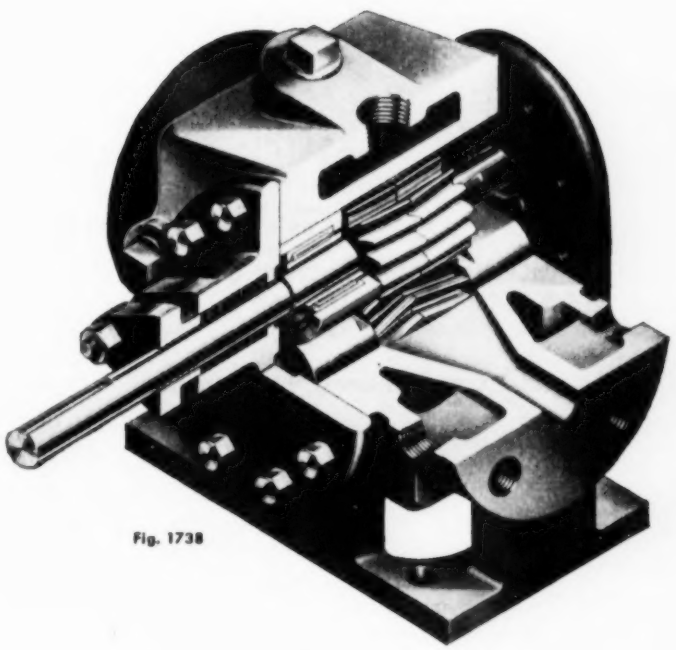

Fig. 1738

You can get many facts on our line of Gear Pumps from our new Bulletin 17-A. It's filled with details on: how these pumps are designed and constructed; how they are used in practically every industrial field; how you can select the proper pump to meet your specs. Cutaway drawings, installation photos, tables of capacities, dimensions, operational data are included to better acquaint you with a type of pump which may be *just right* for you.

Send for a copy of Bulletin 17-A to the address below.

SCHUTTE and KOERTING Company

38 STATE RD., CORNWELLS HEIGHTS, BUCKS COUNTY, PA.
REPRESENTATIVES IN PRINCIPAL CITIES

JOHNSON OIL REFINING COMPANY

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CHICAGO HEIGHTS, ILLINOIS

June 11, 1953

Universal Oil Products Company
30 East Algonquin Road
Des Plaines, Illinois

Attention: Harvey Blankenship

Dear Harvey,

This month, we will reach several milestones in the operation of our Platformer. The date of June 21st, will be the second anniversary of our operations. We are still operating on the original catalyst charge and we have reason to think that it will last some longer. Our operations indicate that we are now making more light ends and that we are getting more hydro-cracking than on past performance but our yields have remained about the same throughout our entire operation.

On June 21st, our anniversary, we will have reached a thru-put of about 1,050,000 barrels and a true platformate production of 971,250 barrels. We will have charged 160 barrels of reactor charge for each lb. of initial catalyst, at a catalyst cost of less than 2.5¢ per barrel.

During the 2 years of operation, we have been down 25 days due to strike and 17 days for inspection, minor repairs and changes. We thought that this information might be of interest and value to you.

Sincerely yours,

W. J. Leenhouts
Refinery Manager

WJL/ds

YES, MR. LEENHOUTS . . .

THIS IS VALUABLE INFORMATION TO EVERY PETROLEUM REFINER

PLATFORMING

. . . developed, designed and licensed by

UNIVERSAL OIL PRODUCTS COMPANY

UOP

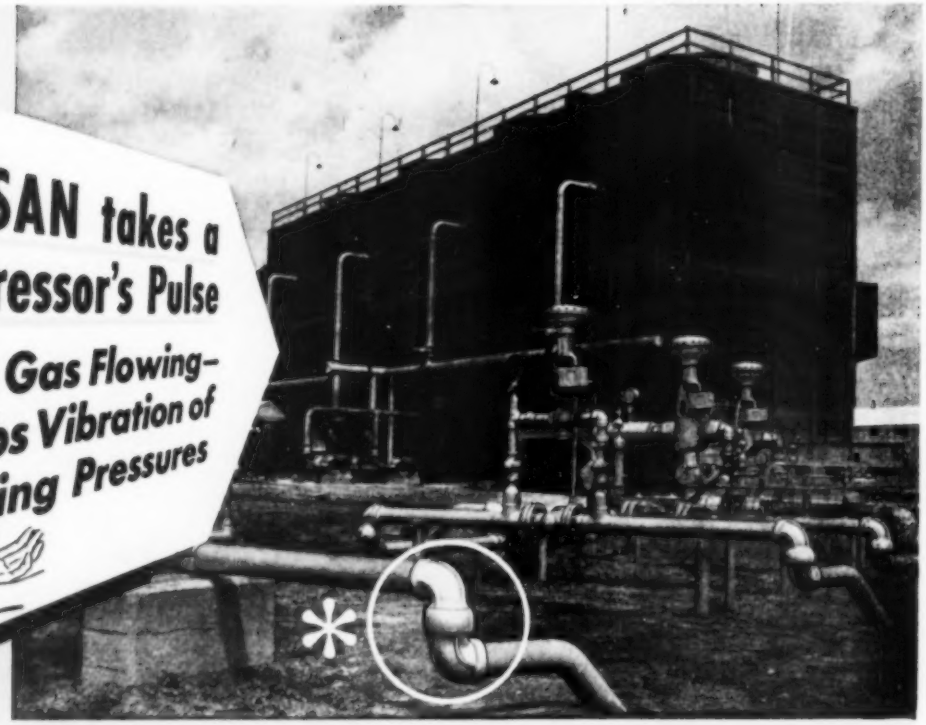
30 ALGONQUIN ROAD, DES PLAINES, ILL., U.S.A.

Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

CHIKSAN takes a Compressor's Pulse

Keeps Gas Flowing—Absorbs Vibration of Changing Pressures



Not only do the stamina and flexibility of Chiksan Joints take expansion in their stride, they absorb pulsation and vibration.

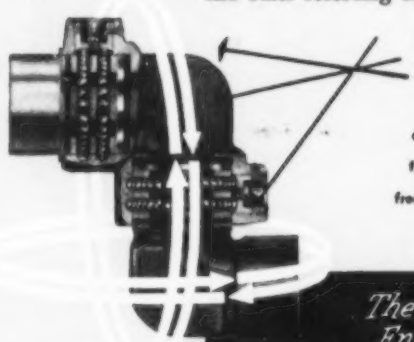
When the Plymouth Oil Company wanted a better way to handle the expansion and contraction of its 2500-3500 lb. natural gas re-pressuring line in its compressor station in Sinton, Texas, back in 1946, it tried Chiksan 2-inch high pressure ball bearing swivel joints. So successful were Chiksan Joints in this application, they were adopted for 3 and 4-inch lines for the same purpose. In addition, by placing regulators, gauges and other recording equipment on a bridge using Chiksan Joints, accurate readings of the instruments could be obtained.

Since 1946, not one of these Chiksan Joints has been replaced or even repacked, and they are giving the same economical, dependable service they did when first installed.

In Texas or California — all over America and all around the world — wherever production, processing or distribution depends on the flow of liquid or gas or on the dependability of hydraulic systems, there you will find Chiksan Ball Bearing Swivel Joints on the job — adding muscle and flexibility — cutting down on shut-downs and maintenance.

Whatever your business, if gas or liquid plays a part, Chiksan's Research and Development Division can help you add efficiency, safety and economy to your operation.

Representatives in Principal Cities
Write for Catalog 53-C, Dept. PR-8.



CHIKSAN Ball Bearing Swivel Joints are THE NEW TOOL of Modern Industry — with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles and sizes have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° to a plus 500° F. with packing materials for each specific type of service.

The Flow of Enterprise Relies on **CHIKSAN** *Ball-Bearing Swivel Joints*

CHIKSAN

TRADE MARK REG.

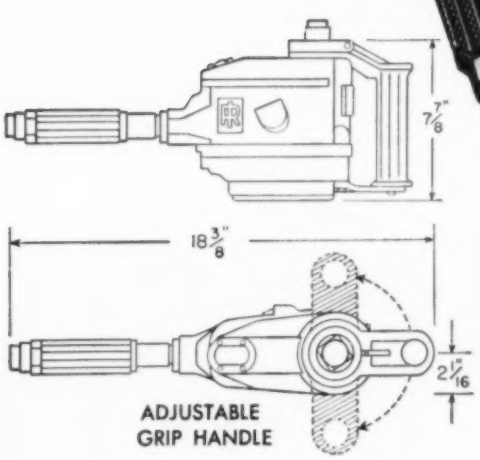
CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey
Weil Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

stop

doing these jobs by hand!

- **STOP STRAINING** on those nuts on high pressure pipe flange jobs.
- **STOP SLUGGING** nuts when repairing steel mill blast furnace gate valves.
- **STOP SWEATING** over those nuts when replacing trays in refinery bubble towers.
- **STOP STRUGGLING** to remove connecting rod bearing cap nuts and oil pan nuts on Diesel locomotives.

Size 518 Air Impactool for ¾" bolt size heavy duty jobs. Weight 23½ pounds.



NEW IMPACTOOL makes tough jobs easy!

The *only* power tool that can be used to do these tough jobs is the new Size 518 Air Impactool. Savings, through greatly reduced downtime, often pay for it on one single maintenance job! The 518 Impactool fits into the tightest places, quickly applies or removes the toughest nuts, with no kick or twist to the operator.

This new Air Impactool is one more addition to a famous line—the world's most complete, versatile, and dependable group of Impactools. Fourteen sizes of Air Impactools for nut running capacities from 7/32" to 4" bolt size.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.

921-B

ORIGINATOR OF IMPACTOOLS • AIR AND ELECTRIC

On these pages are five examples of the variety of heavy-metal equipment designed and built by Alco to solve scores of new industrial problems. Each was made possible by two important factors.

First: Alco is thoroughly familiar with industry's needs. Its designers and engineers have worked closely for many years with power, petroleum, chemical and manufacturing companies in all parts of the world.

Second: Alco has the complete production and testing facilities required to handle efficiently and economically nearly every type of metal fabricating operation.

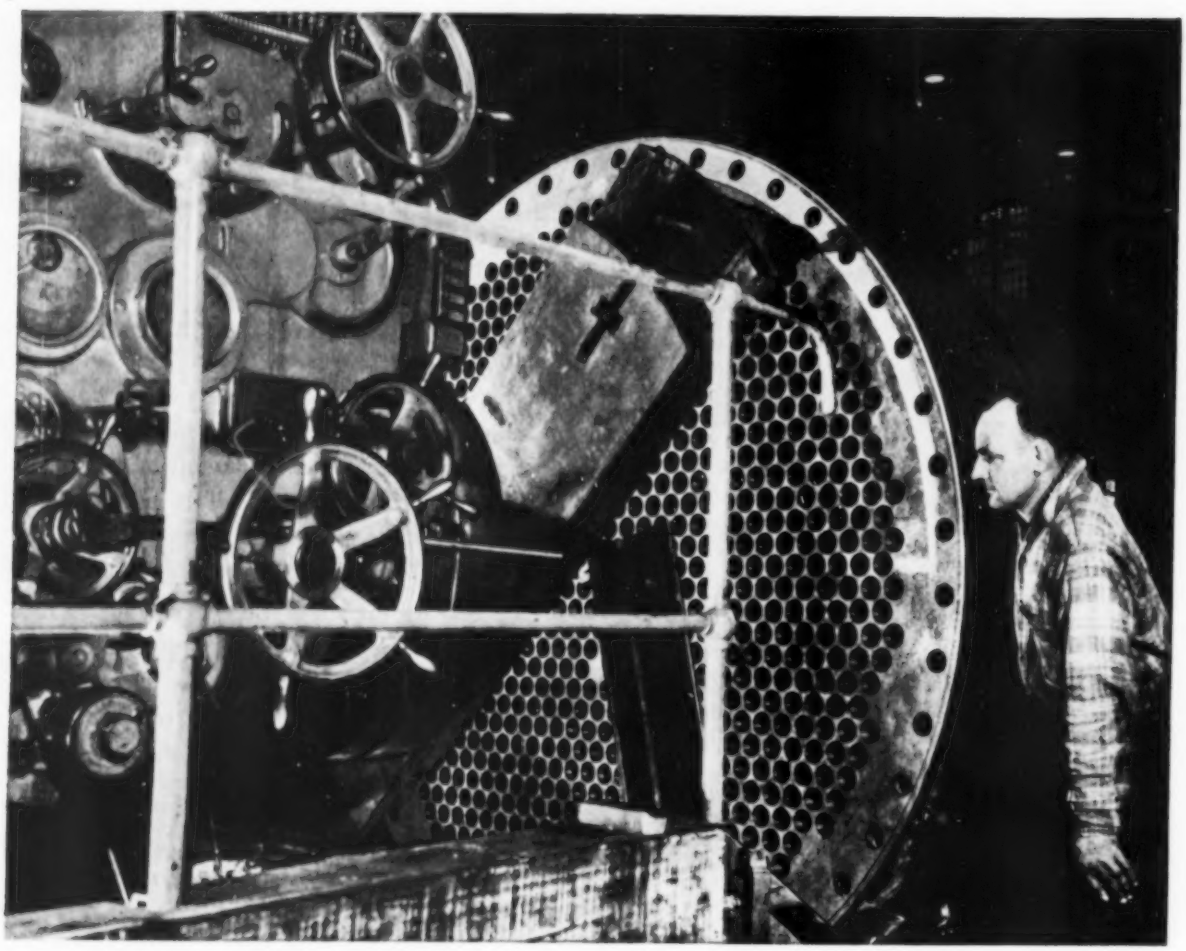
Remember these factors next time you have a problem that calls for something extra in heavy-metal equipment. Then contact your nearest Alco Products Sales Engineer at New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa or Beaumont; or write direct to Dunkirk, N. Y.

How ALCO designs

Answers to

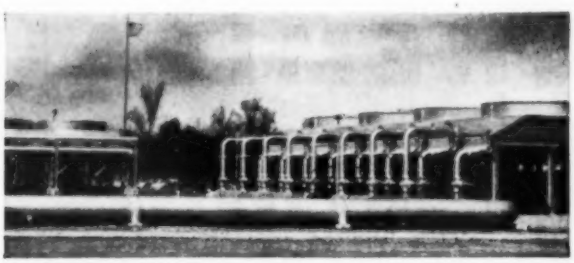
Alco

COMPLETE PRODUCTION FACILITIES, backed by years of experience, enable Alco to fabricate all types of heavy-duty power and processing equipment to meet virtually any specifications. Shown here is a specially designed flange-facing machine in operation at Alco's 31-acre Dunkirk plant.



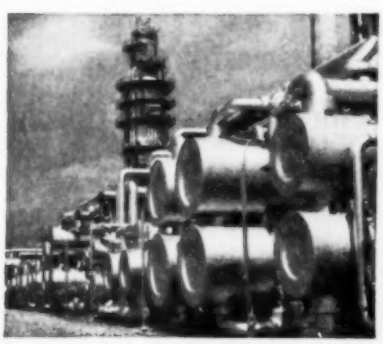
'and builds...

New Industrial Problems



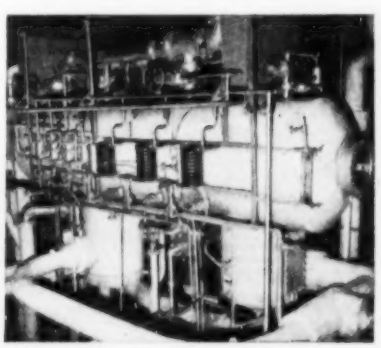
ALCO AIRCOOLERS—the economical answer to a wide range of cooling problems—handle a major part of the heat dissipation at Transcontinental Gas Pipeline Company's modern compressor station at Spartansburg, S. C. Transco also installed these versatile Alco units at their stations near Comer, Ga., and Reidsville, N.C.

ALCO ELECTRIC WELDED STEEL PIPE, available in diameters up to 120 in., is now giving low-cost, high-capacity service in water, gas, oil and sewer installations throughout the country. Furnished in sizes limited only by shipping considerations, Alco pipe helps cut installation time to an absolute minimum.



CUSTOM-BUILT HEAT EXCHANGERS were among the variety of Alco equipment specified for Esso Petroleum Company Limited's giant new refinery at Fawley, England. The largest refinery in Europe, Fawley produces fuels, solvents, lubricating oils and other products at the rate of over 6,000,000 tons a year.

DE-ETHANIZER TOWER was built by Alco to meet the strict requirements of Tennessee Gas Transmission Company's new gas processing plant at Gabe, Kentucky. Years of experience and the most modern manufacturing facilities enable Alco to produce heavy-metal equipment for nearly every purpose.



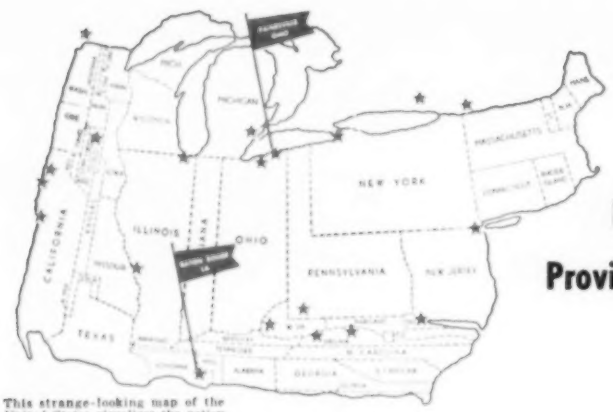
FLEX-TUBE EVAPORATORS at Florida Power Corporation's Bayboro plant at St. Petersburg, Florida, produce 7000 pounds per hour of vapor with a guaranteed purity of 0.9 ppm, based on 2480 ppm shell concentrate. Removal of scale on tube surfaces is greatly facilitated by Alco's patented Flex-Tube construction.

ALCO

ALCO PRODUCTS DIVISION

AMERICAN LOCOMOTIVE COMPANY • DUNKIRK, NEW YORK

Announcing TWO MORE GENERAL CHEMICAL Sulfuric Acid Plants



This strange-looking map of the United States visualizes the nation as it might appear if the size of each state were determined by the value its manufacturing concerns add to the nation's industrial output. It is based upon the figures appearing in the 1949 and 1950 Annual Survey of Manufacturers prepared by the U. S. Department of Commerce, Bureau of the Census.

Now! America's Foremost Producer Provides Industry with 20 *Sources of Supply*

As the nation's needs for Sulfuric Acid spiral steadily upward, General Chemical again adds more plants to its network of sulfuric production facilities in this country and Canada*.

Now, large new acid facilities are going up at Baton Rouge, La., and Painesville, Ohio, to serve expanded demands in those areas. These plants are an important part of the company's continuous, long-range development program aimed at providing Industry with convenient, dependable sources of supply for this vital basic chemical.

That's why—when you deal with General Chemical—you will be served not just by one plant, but through 20. Each augments the facilities and output of the others. Together they form a coast-to-coast "pipeline" that can supply your needs equally well, whether you operate in one location or several . . . from the Great Lakes to the Gulf . . . or from Massachusetts to California.

Just phone or write the nearest General Chemical office for further information on how General's Sulfuric facilities can best be put to work for you.

Allied Chemical

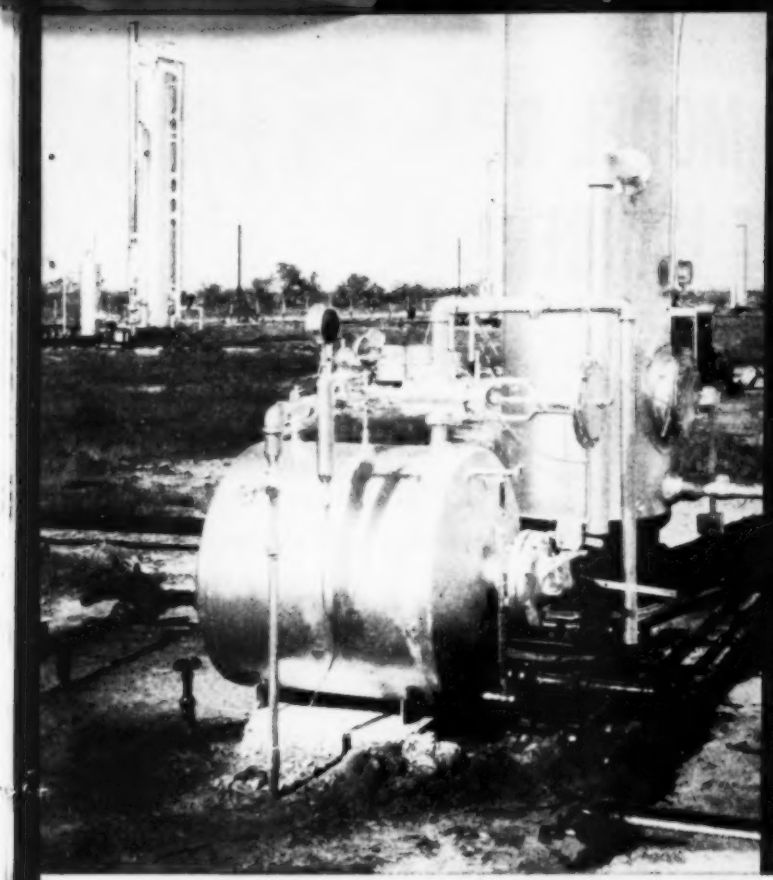
GENERAL CHEMICAL DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

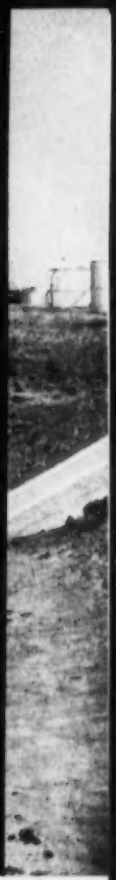
Offices in Principal Industrial Centers from Coast to Coast

*In Canada, The Nichols Chemical Company, Limited



When Ground Must Be Kept Bare of All Fire Hazardous Weeds and Grasses . . . Apply

CONCENTRATED BORASCU® WEED KILLER



NOTHING TO MIX

1

BORASCU is applied dry — directly from sack to soil — prior to seasonal rains; becomes effective when dissolved and soaked into soil.

Just a man . . .
a pail
. . . and BORASCU

Here's real economy, practical as it is thrifty, for your "grassing" operations. Weeds can't grow in ground properly treated with BORASCU . . . areas remain bare one to two years after application! You can figure savings may total as much as 80% compared to old-fashioned hoeing methods . . . that's why BORASCU continues to be first choice with economy-minded production men in oil fields across this continent; from Canada to Venezuela . . . by major and independent operators alike. It is a granular material packed in easy-to-handle 100-lb. multi-wall paper bags. There is *no* risk with safe, non-poisonous, noncorrosive* and nonflammable BORASCU. Write for details today!

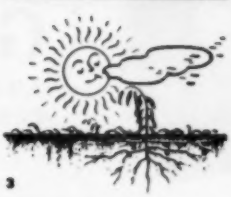
**To Ferrous Metals*

NO WATER TO HAUL

2

RAINFALL adds Borascu to soil solution; quickly carries it to all roots in control area.

NO MORE WEEDS



3

BORASCU in soil solution is taken up by plant roots to complete the killing process.

Literature Available in English or Spanish

PACIFIC COAST BORAX CO.

DIVISION OF BORAX CONSOLIDATED, LIMITED

630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA

•

Borascu Field Men and Distributors are located throughout the Oil Fields of U.S.A., Canada, Mexico, Colombia, and Venezuela.

The New GRINNELL MODEL R CONSTANT SUPPORT HANGER

Mathematically perfect constant support for all positions of travel of high temperature process and steam piping

With the new Grinnell Model R Constant Support, the pipe, its covering and contents, are supplied mathematically perfect support in all positions of travel. In addition, constant support is maintained throughout the full range of field adjustability.

The design of the new Model R provides favorably small ratios between spring force and the supported load, ranging from 1.15 to 1 minimum and 4 to 1 maximum, thereby minimizing bearing stress and prolonging the life of the hanger. This permits hangers which are smaller in size for the loads carried.

If conditions require a change of supporting force, a load scale is provided so that accurate field adjustments of at least plus or minus 10% may be made by turning a *single* load adjusting bolt. Wherever the adjustment is set, the Model R gives a load deflection curve that is a straight horizontal line.

FEATURES OF GRINNELL MODEL R CONSTANT SUPPORT HANGER:

- 3 frame sizes provide maximum travel of 4 inches, 8 inches and 12 inches respectively to accommodate all loads from 48 to 9,304 pounds
- Non-resonant
- Anti-friction needle bearings keep friction to a minimum
- Individually calibrated before shipment to support exact load specified
- Requires less head room
- Can be bolted directly to the building structure or suspended by either single or double rods

SEND FOR DETAILED CATALOG ON NEW GRINNELL MODEL R CONSTANT SUPPORT HANGER

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

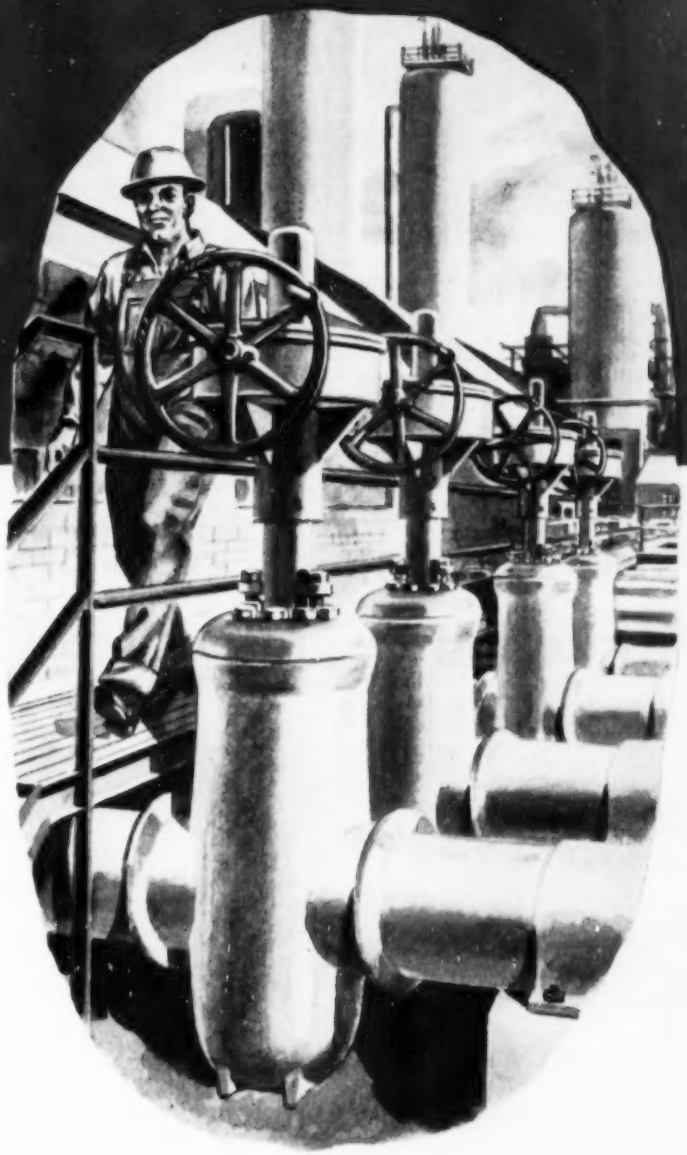
Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

"FOUR YEARS' FLUE-GAS SERVICE AT 800° F. AND STILL IN EXCELLENT CONDITION..."

W-K-M PROCESS VALVES

(PATENTED)



Four years ago a large southwestern oil refinery installed four 12" W-K-M Process Valves in the flue-gas lines of a hydroformer unit. The flue-gas, containing sulphur, passed through the valves at 800° F. at a pressure of 300 p.s.i. A recent check showed that the valves were still in good shape and the seating surfaces were in good condition.

These valves were standard steel trim except for the seating surfaces which were inlaid with Hastelloy alloy B, which trim is also used for such severe services as hydrochloric acid solutions, sulphuric acid solutions, isopropyl alcohol, hot rich oil and propane and butane.

W-K-M Process Valves have all the features of the Standard W-K-M Valves, such as exclusive leverlock operation, parallel expanding gate assembly, through conduit flow and renewable seats plus other design features especially developed to meet the needs of process service.

Write for W-K-M Bulletin 698 for complete information about W-K-M Process Valves.

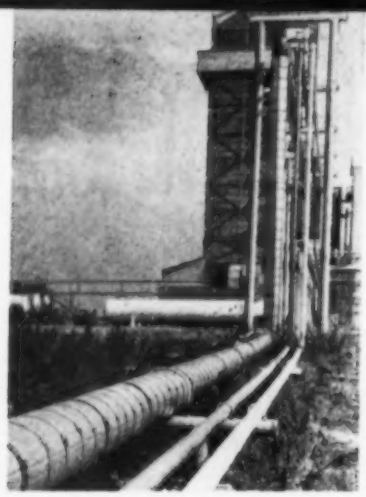
W-K-M Valves

W-K-M Company, P. O. Box 2117, Houston 1, Texas

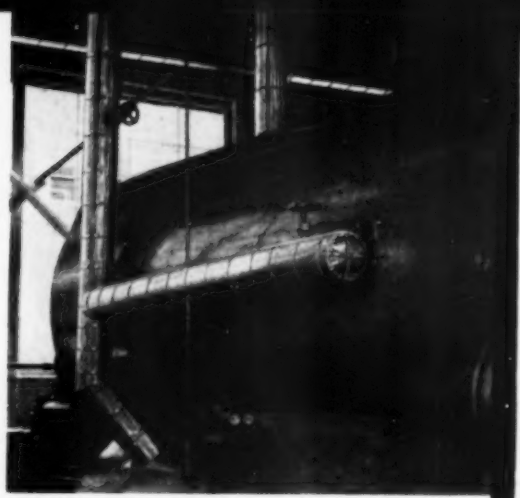
2330 E. 8th St., Los Angeles, Calif.

Export Office: 30 Rockefeller Plaza, New York, N. Y.

This big new Oklahoma refinery has used a new kind of aluminum jacketing throughout on both insulated lines and towers and vessels. Light in weight and low in cost, this new Childers Aluminum Jacketing cut installation costs. It is also expected to cut maintenance costs.



Childers Aluminum Jacketing is used here on a cross-country transfer line at a large chemical manufacturing plant in Texas. This is a rugged test for any jacketing, but the light-weight aluminum used in this jacketing should stand up to weather and chemical corrosion it encounters.

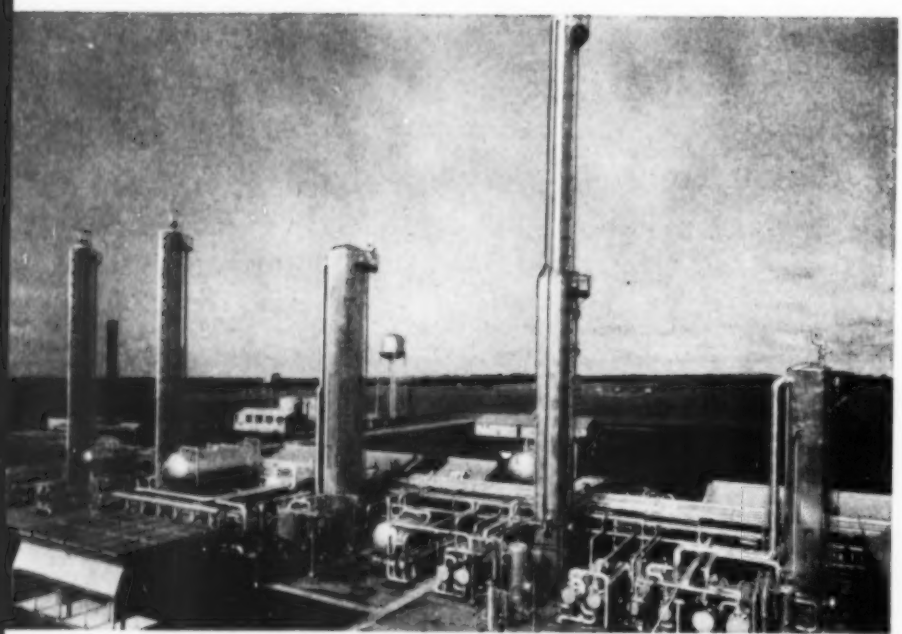


"Good Housekeeping" is the word in this gas pipeline pump station. The insulated lines are handsomely protected by Childers Aluminum Jacketing, which should last as long as the plant itself. The jacketing requires no painting and very little other maintenance. It even allows the interior of the plant to be washed with a hose without harm to the insulation. The chief engineer reports: "We have standardized on Childers Jacketing for all our insulated lines. It is doing an excellent job for us and saving us money."

How 5 plants cut costs of jacketing insulated lines

Weather-resistant, low-cost, easy to put on—these are big reasons for the growing popularity of a new jacketing, specially engineered for insulated lines. It is made of .006" thick aluminum and comes with or without a moisture barrier. It is called Childers Aluminum Weatherproof Jacketing. You can write for a free sample without obligation.

Address Childers Manufacturing Co., Dept. PR-15, 3620 W. 11th St., Houston 8, Texas.

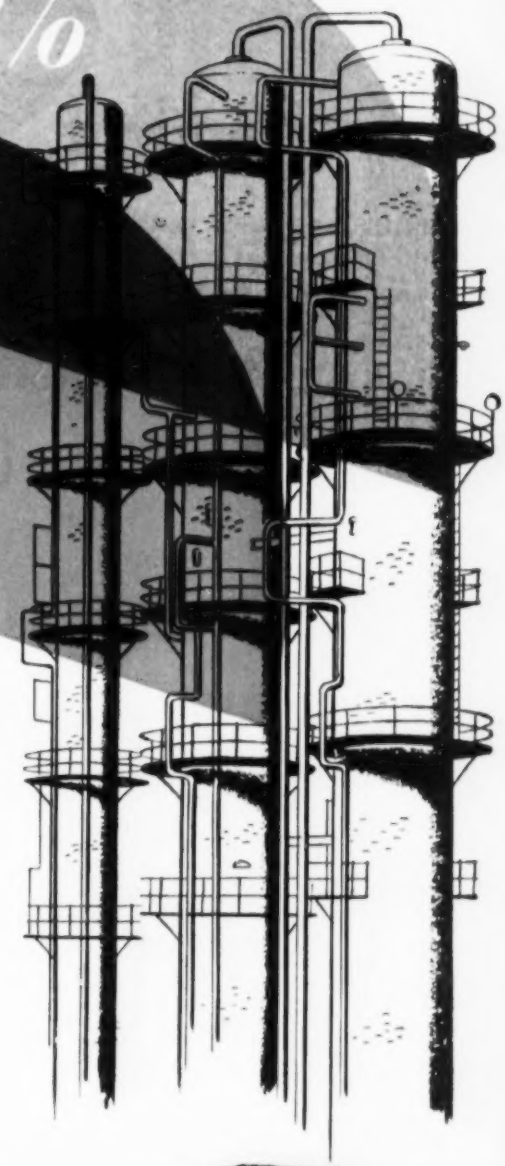


Weather, wind and corrosive gases are not going to attack the insulation of this new plains-country gasoline plant. The insulation is protected by long-lasting aluminum: Childers Aluminum Weatherproof Jacketing. The management expects this low-cost jacketing to hold insulation maintenance costs to a minimum. Other advantages are that the jacketing went on quick and easy during construction; it required no special tools or skill—no shop forming or cutting. It can be taken off and re-used if lines are moved. Aluminum saves on painting and the tough 3S alloy used for Childers Jacketing should stand up for years even in highly corrosive industrial atmospheres. Check the advantages of this jacketing for your own plant.

Amazingly easy to handle, Childers Jacketing was applied here by men using no more than a wooden wedge and a pair of pliers. Childers has engineering representatives in every major industrial center who will be glad to confer with you on your particular jacketing problems. Write to address shown above.

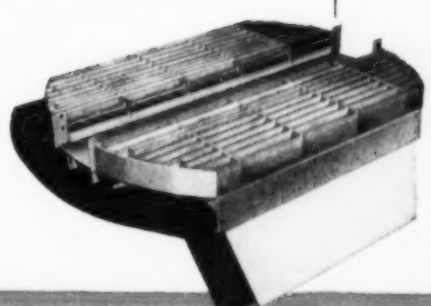
Advertisement

You can save 30% to 50% of your tower costs



Design Factors	Bubble Trays	"Benturi" Kaskades
Low vapor thruput	+	−
High vapor thruput	−	+
Low liquid thruput	+	−
High liquid thruput	−	+
Low pressure drop	−	+
High pressure drop	+	−
High pressure towers	−	+
Low pressure towers	+	+
Alloy or alloy-clad towers	−	++
Shop fabricated towers	−	+
Field fabricated towers	−	++

Check your requirements on this simple chart. While any one of the "plus" features justify the economy of Koch "Benturi" Kaskade trays, a combination of these conditions provides a "bonanza" to the operator. We'll be glad to give you data on "Benturi" installations to fit your requirements. No obligation.



KOCH ENGINEERING COMPANY, INC.

DESIGNERS • MANUFACTURERS • BUILDERS

321 WEST DOUGLAS WICHITA 2, KANSAS

REPRESENTATIVES

Eastern and Export
30 Rockefeller Plaza
New York City

Pittsburgh, Pa., Repr.
D. D. Foster Co.
501 Alcoa Building

Tulsa, Okla., Repr.
Myers-Bogwell Co.
Wright Building

British Associates
Messrs. A. F. Craig & Co., Ltd.
Paisley, Scotland

TO

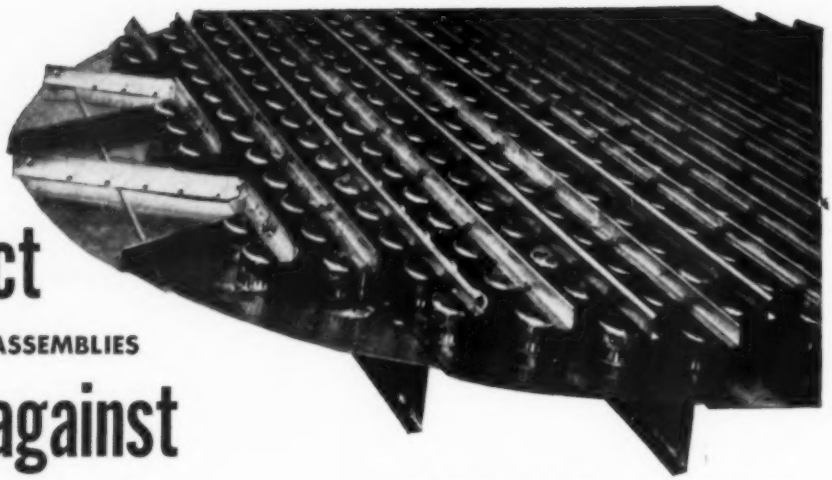
protect

YOUR CAP AND TRAY ASSEMBLIES

against

CORROSION

damage



Fritz W. Glitsch & Sons, Inc., Dallas, Texas, fabricated this lightweight bubble cap and tray assembly of corrosion-resisting Monel to withstand hydrochloric acid corrosion in the top section of a refinery fractionating tower. The strength and ductility of wrought Monel and Inconel lessen chances of breakage during installation. Trays which have been distorted by explosion can readily be straightened in the field.

There are two commercial non-ferrous metals that offer the protection your fractionating and distillation equipment needs.

Each gives you excellent corrosion resistance...*plus* high strength ...*plus* toughness...*plus* ductility.

Both metals are Inco nickel alloys – Monel and Inconel.

Their properties make it possible to use relatively thin-gauge metal for many applications. This means, of course, that you get lighter assemblies. Your cost for materials is lower...and installation and maintenance easier.

What governs your choice of Monel or Inconel? For the most part, it depends on service conditions.

Monel caps and trays are usually preferred where operating temperatures remain below 500°F. They are used to withstand the effects of dilute hydrochloric acid and wet sulfur types of corrosion in the upper sections of fractionating towers...and in the regeneration of spent caustic soda. Inconel, the nickel-chromium alloy, is used to resist high-temperature oxidation attack and naphthenic acids.

A wide range of designs is possible with Monel and Inconel. All are readily fabricated. They can be cut, formed, machined and welded by ordinary shop methods. They need no heat treatment after fabrication to develop maximum resistance to corrosion.

Keep Monel and Inconel in mind when you run into problems involving the use of metals in fractionation. And call on Inco's Technical Service for all the help you need. They have a world of information on hand, and are always glad to share it with you. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Successful Experiment. Here you see the excellent condition of a Monel cap and tray assembly after extensive experimental service at the top of a caustic soda regenerator unit. Note how badly the adjacent steel wall has been corroded. In the same column, a steel tray with cast iron bubble caps ➧ was located directly beneath the all-Monel top assembly. Corrosion made visible progress on the lower assembly, while the top tray and caps easily withstood attack.

Because of defense needs, Inco Nickel Alloys are now on extended delivery. Orders should be placed well in advance, together with NPA rating and complete end-use information.

Inco Nickel ALLOYS

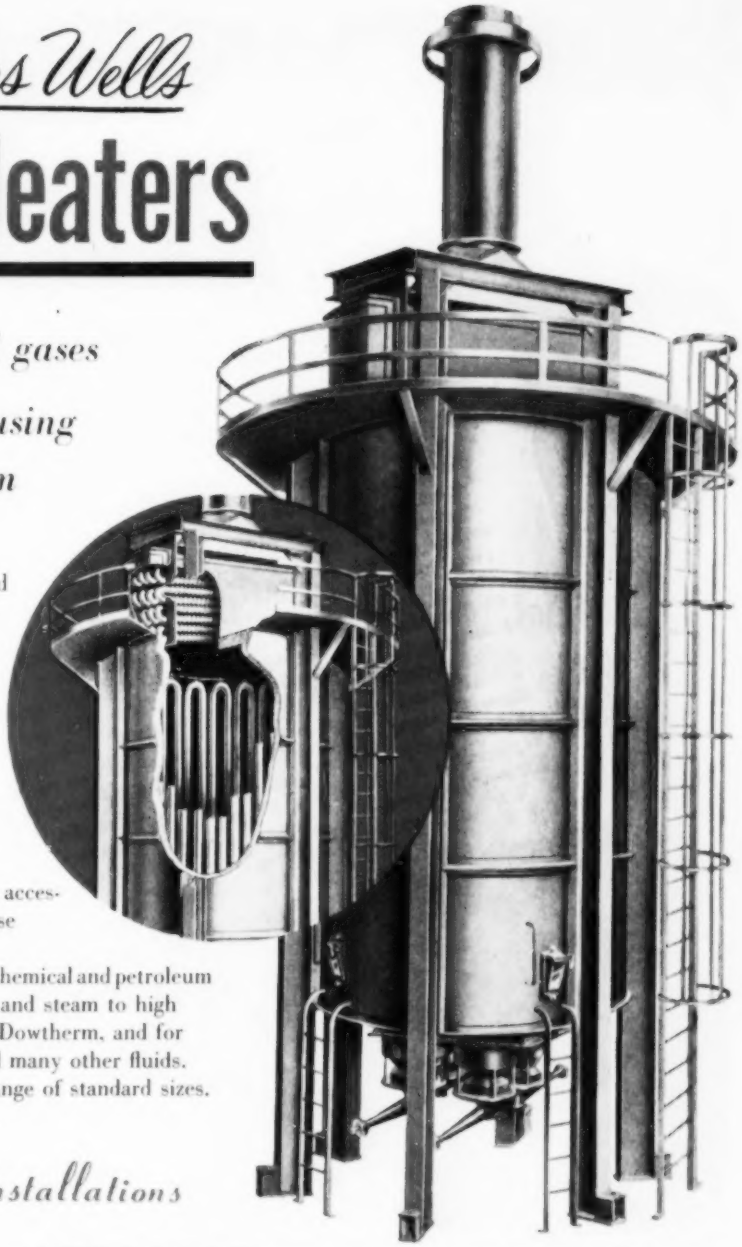
Monel® • "R"® Monel • "K"® Monel • "KR"® Monel "S"® Monel • Nickel • Low Carbon Nickel Duranickel® • Inconel® • Inconel "X"® Inconel "W"® • Incoloy® • Nimonic® Alloys

Struthers Wells

Fired Heaters

For heating liquids and gases

For indirect heating using circulating medium



The Struthers Wells fired heater is designed to give efficient and trouble-free operation in a wide range of services.

Moderate rates of heat input, symmetrical arrangement of tubes, and the liberal heat absorption surface provided, eliminate overheating of the equipment or the heated fluid.

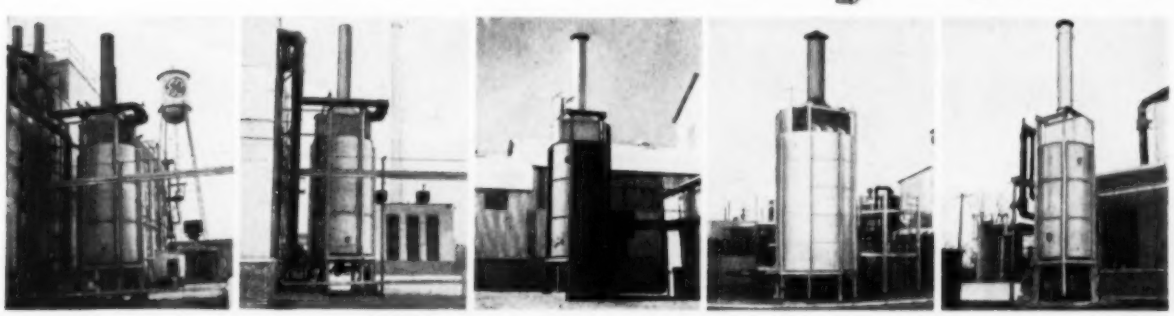
High thermal efficiencies are secured; the convection section surface is provided with heavy welded fins.

Equipment is provided with all necessary accessory and control equipment if required: close temperature control may be secured.

This equipment is being widely used in the chemical and petroleum industries for heating air, hydrocarbon gas and steam to high temperatures, for indirect heating utilizing Dowtherm, and for direct heating of absorption oil, asphalt and many other fluids.

Good deliveries are available in a wide range of standard sizes.

Typical Installations



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STRUTHERS WELLS CORPORATION

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TWO TERRY TURBINES IN RECORD NON-STOP RUN AT CITIES SERVICE

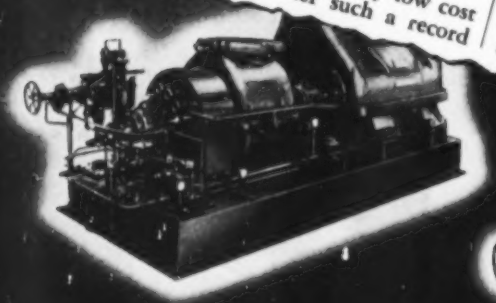
After 26 Months of Continuous Operation, Cost of Replacement Parts Only $78.00 for Each Turbine

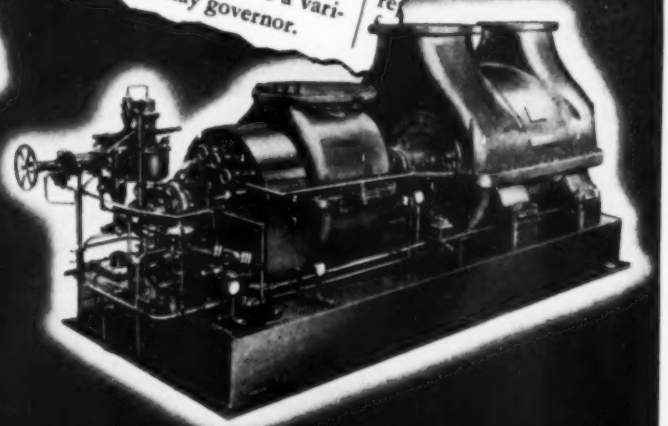
Two Terry turbines recently completed a record non-stop run at the East Chicago refinery of Cities Service Oil Company. Specially designed for driving air blowers on fluid catalytic cracking, they ran continuously *from initial start up*, day and night, for two years and two months. Throughout the entire run neither turbine suffered any noticeable reduction in efficiency.

On inspection, after shutdown, it was found that the only parts showing signs of wear were the shaft packing rings. These were replaced at a total cost of $78.00 for each turbine.

While this extremely low cost for repairs, after such a record run, could not have been anticipated, Cities Service had good reason to expect outstanding performance from Terry turbines. A four-year record of 216 Terry turbines at the Lake Charles refinery of this same company showed amazingly low maintenance costs. During this period, the yearly cost of replacement parts averaged only 1.4% of the initial investment.

The two turbines at East Chicago are rated 2450 horsepower at 5030 rpm. Each is equipped with a trip throttle valve, forced feed lubrication, and regulator for process control applied to a variable speed oil relay governor.





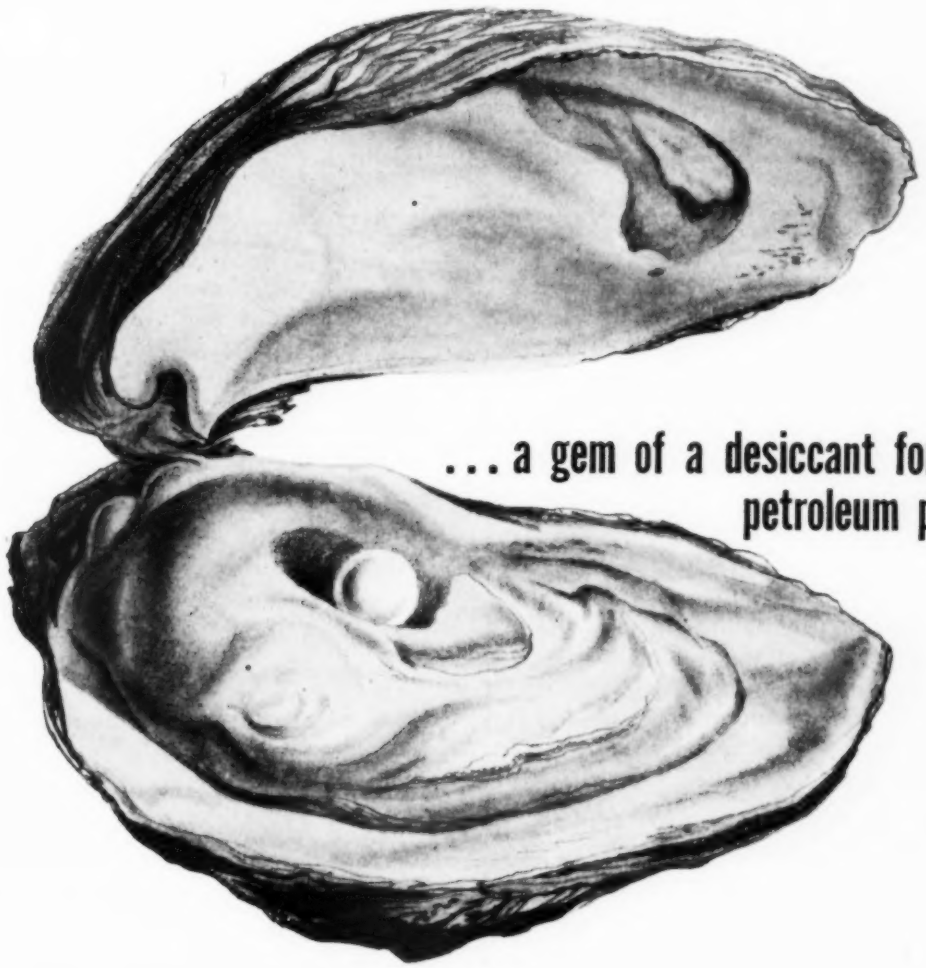
For more information about Terry multistage turbines, send for a copy of Bulletin S-146. No cost or obligation.

TERRY

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1193

Alcoa's new Activated Alumina



. . . a gem of a desiccant for petroleum processing

Here, at last, is the ideal desiccant—ALCOA's latest and most efficient *Activated** Alumina, H-151 in ball form.

ALCOA Activated Alumina is the "old reliable" among drying agents, widely used in petroleum processing to dry liquids and gases to *lower* dew points than any other commercial adsorbent. Now the new H-151 series provides *longer* life . . . *higher* capacity . . . *lower* pressure drop . . . *greater* physical stability than ever before offered to the petroleum industry.

ALCOA Activated Alumina is commercially pure, highly inert, and possesses remarkably high resistance to crushing, abrasion, and thermal and mechanical shock. It will not change its form or properties—even when immersed in water—and can be reactivated almost indefinitely.

Call your nearest ALCOA sales office or write for complete data on this new, amorphous gel type Activated Alumina. Investigate its application to *your* processing problems today.

Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-H Alcoa Building, Pittsburgh 19, Pa.

Alcoa Chemicals

ALUMINUM COMPANY OF AMERICA

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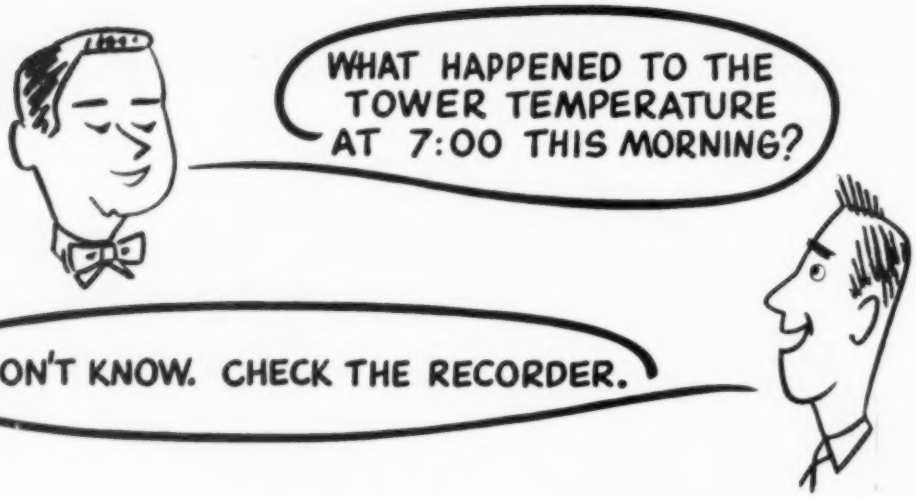
Don't forget ALCOA Utilitube*—aluminum instrument air tubing in long lengths.



WHAT MAKES A RECORDER GOOD?

Many things. For instance, in the new Thermo Electronic indicating-recorder overall design is simple. The recording system only has three moving parts.

That's one thing. Here's another: the pen arm is driven from a cam. This permits linear charts to be used for almost all measurements, despite the non-linearity of the sensitive element characteristics. When warped or expanded scales are desired, special cams can be supplied.

Furthermore, nylon drive gears are used to provide long life and quiet operation.

There are many other things. If you want to hear about them, let us know. We'll be glad to supply the information. Ask for Catalog No. 60 X.

AT THE ISA SHOW

This indicating-recorder, along with T-E's other pyrometric equipment, will be at the Instrument Society of America Exhibit, Sherman Hotel, Chicago, Ill., Sept. 21-25, Booth 59.

Even if everything goes the way it should with any process where temperature is involved, sometimes it's important to *prove* everything went right. On the other hand, if something is wrong, if standards aren't met, then it's very important to *know* what went wrong in order to correct it. Was it temperature? Or some other process variable?

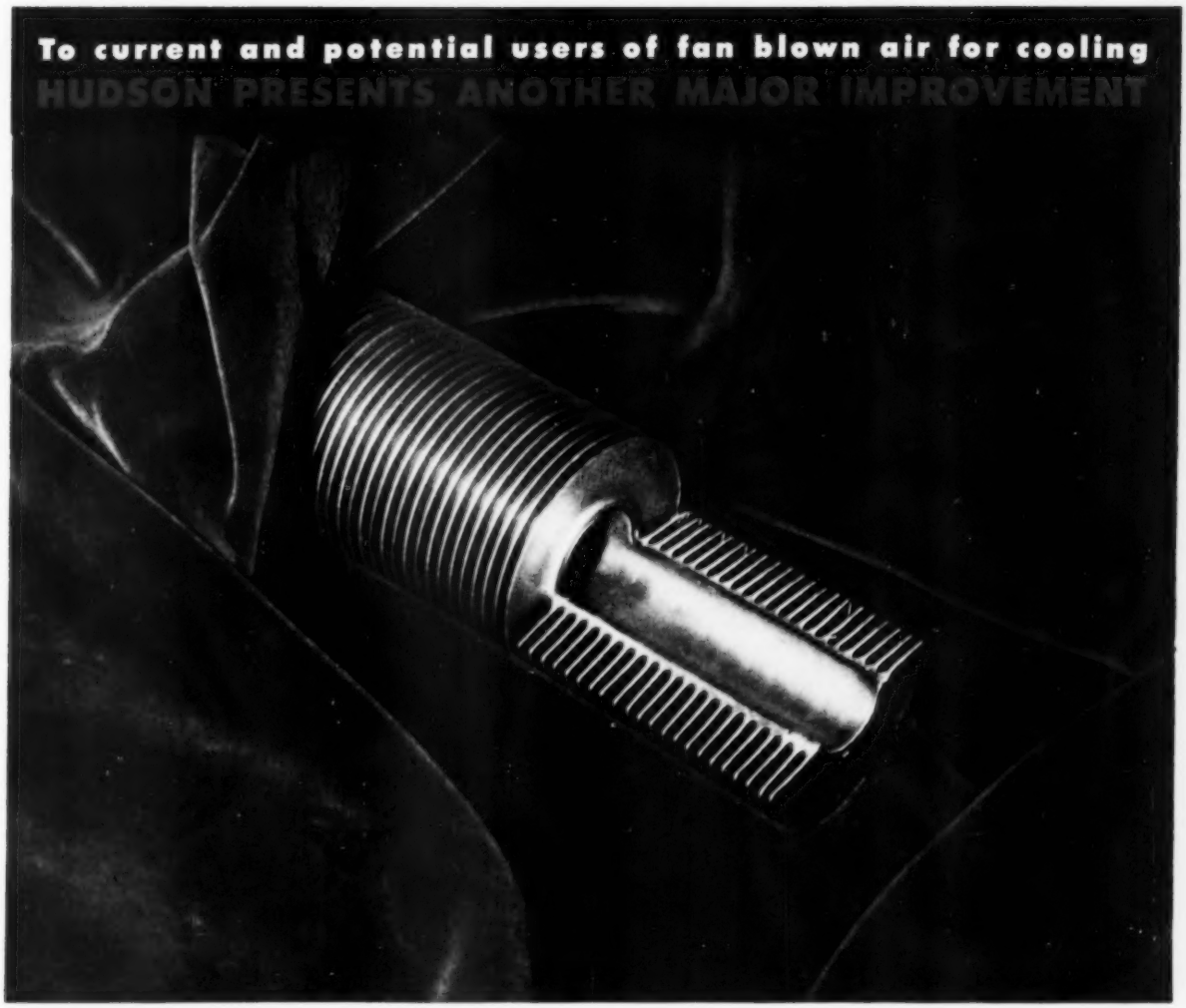
When an accurate temperature recorder is on hand, a quick check of the record will tell you if temperature was too high, or low, and for how long. If the temperature was off, your problem is pinpointed and you can work on it right away. If it wasn't, you can go on to other variables and find the troublemaker. Either way, a good recorder is a time-saver.

Thermo Electric makes a good recorder —it is accurate (±¼ of 1% of the range), sensitive (better than ±1/20 of 1%), durable, and can be used to record variations in temperature, humidity, solution conductivity, speed, pH, direct current, DC voltage, strain, or other variables. Both potentiometer pyrometer and resistance thermometer bridge types are available, depending on the application.

Thermo Electric Co., Inc.
FAIR LAWN NEW JERSEY

To current and potential users of fan blown air for cooling

HUDSON PRESENTS ANOTHER MAJOR IMPROVEMENT



the NEW HUDSON HY-FIN DOUBLE TUBE

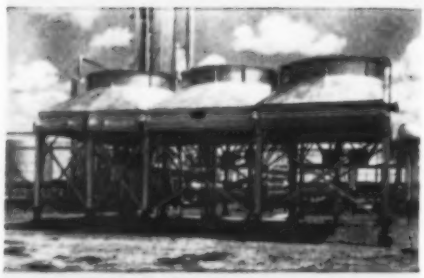
Now employed in HUDSON SOLO-AIRE and HUDSON COMBIN-AIRE units

The HUDSON HY-FIN is made possible through the development at HUDSON'S Houston plant of a special machine to form by cold extrusion from the metal of the tube itself closely spaced, uniform, extremely **high** fins, with integral surfaces of tube and extruded fins being smooth and streamlined.

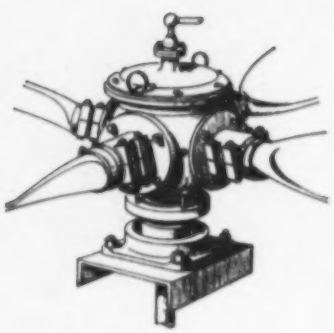
The finned outer tube is usually aluminum alloy, the inner tube may be admiralty, copper, steel, or alloyed steel. The two concentric, snugly fitted tubes with solid mandrel inside the inner tube are fed to the HUDSON HY-FIN machine where tremendous pressures serve to simultaneously extrude most of the metal of the outside tube into high fins, and to form a complete bond between the two tubes.

ADVANTAGES . . . See reverse side

No other hot fluid to air exchanger has all of the following advantages of HUDSON Solo-aire units using HUDSON HY-FIN DOUBLE TUBE



SOLO-AIRE — in which air alone is used for cooling.



AUTO-VARIABLE FAN — automatic variation in fan pitch gives perfect control of cooled fluid temperature and saves horsepower.

COMBIN-AIRE — in which air and water in combination are used for cooling.

1. VERY HIGH HEAT TRANSFER PER LINEAL FOOT OF TUBING. The height of the fins, their extrusion from the tube itself (no crimping or welding), and the perfect bond between tubes, are the reasons.
2. LOW AIR HORSEPOWER REQUIREMENTS. The higher heat transfer rates allow the use of greater spreads between inlet and outlet air temperatures; hence less air mass is moved and less pressure drop encountered for a given heat removal.
3. RUGGED, DURABLE FINS. The strong, integral, smooth fins allow ease in cleaning, and are not susceptible to damage in transit, cleaning, or in operation.
4. ADAPTABILITY. The inner tube may be selected from a variety of materials to best resist corrosion or withstand temperature of the hot fluid. The outer finned tube is resistant to salt air and other atmospheric corrosion, and completely protects the inner tube from such corrosion. HUDSON HY-FIN tubes are in use in oil refinery services cooling corrosive hot fluids at temperatures above 650 °F.
5. UNDIVIDED RESPONSIBILITY. The HUDSON HY-FIN assembly is manufactured from bare tubes by HUDSON and each tube and each step in the manufacture is subjected to rigid inspection to eliminate hidden defects.

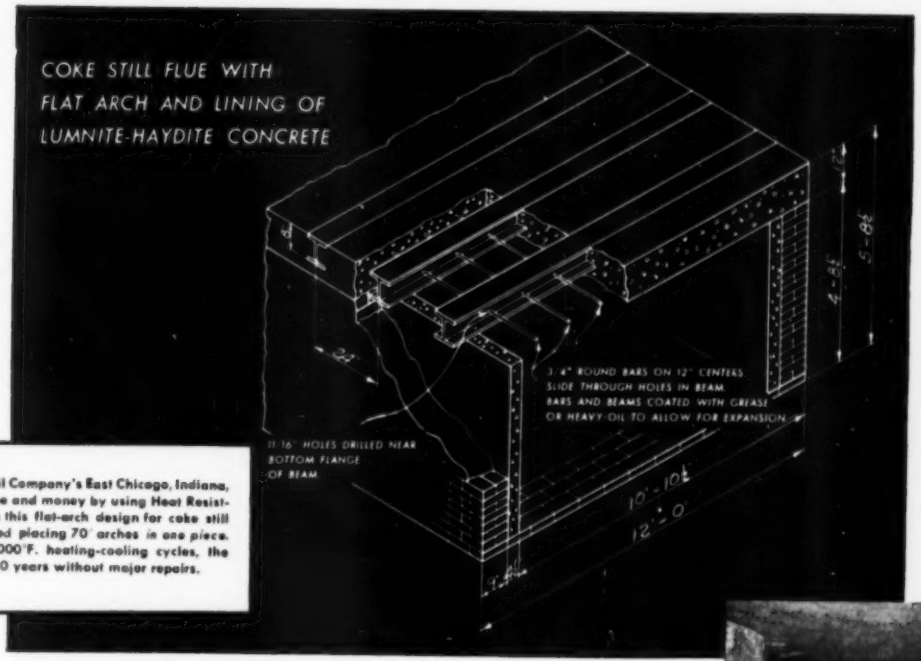
The HY-FIN tube is another in the long list of improvements that have resulted from the constant effort to maintain and advance the quality and utility of HUDSON equipment.

HUDSON HY-FIN tubes are manufactured under one or more of three United States Patents. Other patents are pending.

HY-FIN, SOLO-AIRE and COMBIN-AIRE are registered trademarks.

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION • HOUSTON, TEXAS

Special Industrial Concrete Cuts Refinery Costs


COKE STILL FLUE WITH
FLAT ARCH AND LINING OF
LUMNITE-HAYDITE CONCRETE
3/4" ROUND BARS ON 12" CENTERS
SLIDE THROUGH HOLES IN BEAM
BARS AND BEAMS COATED WITH GREASE
OR HEAVY OIL TO ALLOW FOR EXPANSION
11/16" HOLES DRILLED NEAR
BOTTOM FLANGE
OF BEAM

Cities Service Oil Company's East Chicago, Indiana, plant saved time and money by using Heat Resistant Concrete in this flat-arch design for coke still flue. It permitted placing 70' arches in one piece. And despite 1000°F. heating-cooling cycles, the arches served 10 years without major repairs.

...resists high temperatures... corrosion... thermal shock

In more and more refinery installations, such as the one shown here at Cities Service, East Chicago, Indiana, plant, costs are being trimmed and efficiency boosted by using industrial concrete where heat and corrosion exist.

In addition to the usual convenience and structural advantages of concrete, special concretes made with Lumnite* calcium-aluminate cement provide:

HEAT RESISTANCE—*up to 2600°F.*

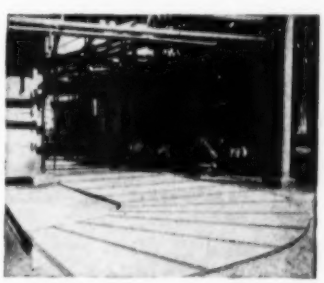
CORROSION RESISTANCE—*with suitable aggregates*

INSULATION—*with insulating aggregate*

Lumnite concrete can be easily placed by plant labor, if maintenance repairs are needed, and is strong enough for service within 24 hours.

Castables for convenience — Make Refractory Concrete with prepared castable mixes of Lumnite cement and aggregate selected for specific temperature and *insulation* requirements — only water is added. They're made by refractory manufacturers and sold through their dealers. For more information, write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Ave., New York 17, N. Y.

TAKES HEAT IN STRIDE—Coke still gases enter the Heat Resistant Concrete flue at a temperature of approximately 1000°F. As you can see, it's still in good condition after a decade of service.



MAKES CURVES EASY—Although the flat arch of this flue curves alongside the coke still, construction was simple with poured-in-place Lumnite Concrete. This plant also uses it for linings in header castings, heaters, stacks, fire doors, vessels of all types and rush concrete work.

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PR-L-778

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

A UNIVERSAL ATLAS PRODUCT

this is the new, improved way that Wolverine can speed your installations of CONDENSER TUBES

Ask for Shipments in **"U-BEND"** *pallets*

•

SAVE TIME *and* MONEY

Now provide yourself with a stand-by unit. Have the required replacement of condenser tubes (either plain or finned) at hand—ready for quick and efficient installation.

Arranged in a wooden pallet according to predetermined order (a whole complement of tubes, if required), the tubes can be fed as one unit directly into the condenser or heat exchanger with a great saving of time. Tube-unloading, inspection, assembly, handling and installation costs are thus materially reduced.

Each pallet is designed and constructed to suit your individual requirements. It will withstand the handling in transit. You'll receive the tubes arranged in the order you'll use them and in the perfect condition you expect them. And, too, in this condensed package form they occupy comparatively small storage space and can be easily stacked.

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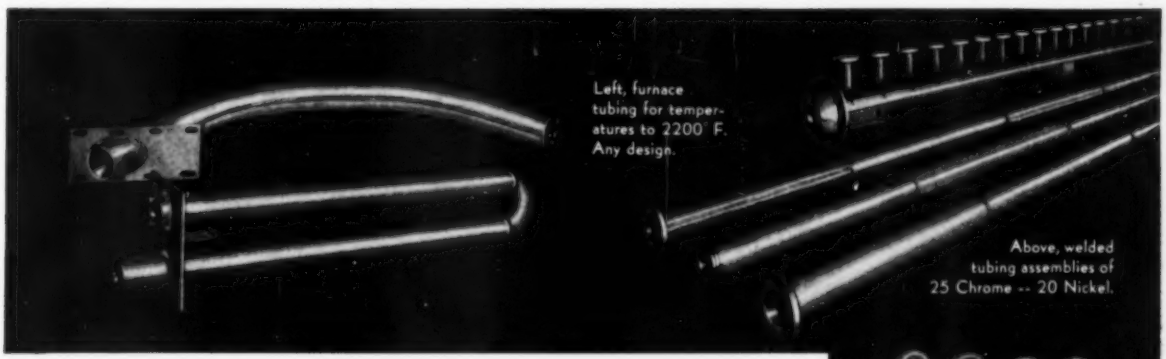


Left, furnace tubing for temperatures to 2200° F. Any design.

Above, welded tubing assemblies of 25 Chrome -- 20 Nickel.

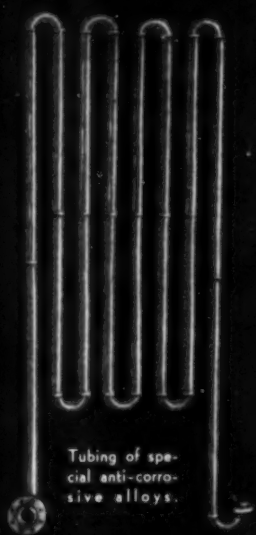
Cut Your Tubing Costs 3 Ways with PSC 'Thin Wall' Construction

Some customers have found that PSC process piping has cut their costs over 50%. Take for example a company which had been using 3" tubing of standard I. P. S. .216" wall thickness, on an application where pressure and erosion were low, but temperature and corrosion conditions were constantly troublesome. They installed PSC tubing of only 16 gauge (1/16" section) but of a metal analysis suited to solve their troubles. The saving in metal in this case was over 71%.

At the cost of alloy steels, this was very substantial. But this customer saved two other ways also: In the lower fabricating cost of light gauges. And, lastly, in the less labor and material required to install PSC light-weight welded alloy tubing. We have no record of the replacement saving they are now enjoying.

But the life/cost ratios of PSC process tubing are impressive. PSC process piping is furnished in any diameter up to 60" and in any alloy. We specialize in precision fabrication of complex tubing assemblies.

Send for **Process Equipm't CATALOG 52**



Tubing of special anti-corrosive alloys.

PSC light-weight welded alloy tubing facilitates construction problems in handling gases.

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The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

. . . with a LJUNGSTROM *air* PREHEATER

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Preheated air is a key factor in more efficient combustion, causing faster ignition and a short, hot flame. Rates of heat liberation are higher, too. Thus, with preheated air, low grade fuels with high ash and moisture content – and excessively lean fuels – are readily burned.

You get other advantages with a Ljungstrom, too: lower fuel costs . . . more economical furnace design . . . greater throughput . . . higher product quality – *all of these with the Ljungstrom, that pays out in just a few months.*

Wherever you are planning to expand or modernize your fuel burning equipment, it will pay you to consider a Ljungstrom Air Preheater. Call or write for full information.

THE AIR PREHEATER CORPORATION
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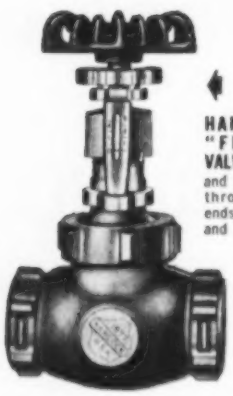
Here's manual control of flow, temperature and pressure that's really precise. Hancock "Flocontrol" Valves, with micrometer dial and pointer mounted on the bonnet, permit settings to within 1/100th turn of the handwheel! Equally important, any setting can be duplicated easily, perfectly — any time.

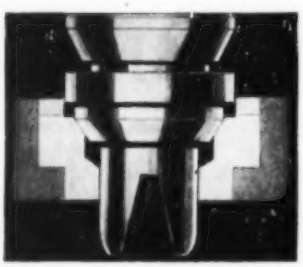
Hancock "Flocontrol" "3 in 1" design gives you the advantages of a variable orifice, plus a shut-off, plus an index . . . all in "one package." Bronze and steel types are available. Both have a scientifically designed V-Port valve disc that *compels proportional flow throughout the entire lift of the valve stem.* The shut-off seating surface is entirely removed and separate from the controlling V-Ports. Super-finished "500 Brinell" stainless steel seats and discs minimize the effects of wire-drawing and steam cutting.

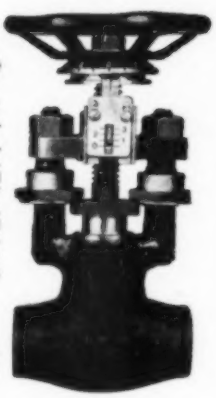
For fine throttling control and proportional flow . . . for greatest efficiency, lowest operating costs — install strong, dependable Hancock "Flocontrol" Valves in your lines. Your nearby Hancock Distributor will gladly give you full details.

When Hancocks go in, valve costs go down



HANCOCK BRONZE "FLOCONTROL" VALVES. **Types:** Globe and Angle. **Sizes:** ¼" through 2". Screwed ends. Available in 150# and 300# Series.





HANCOCK 600# STEEL "FLOCONTROL" WELDVALVES. **Types:** Globe and Angle. Outside Screw and Yoke. **Sizes:** ¼" through 4". Screwed, Socket Welding and Flanged Ends. Available with 150#, 300# and 600# Series Flanges.

VALVE SEAT AND V-PORT DISC fully closed. As the valve is opened proportional flow is gradually increased. The Hancock "Flocontrol" Valve has straight-line flow. Its regulation does not depend on the short-wearing, fine threads common to a needle valve.

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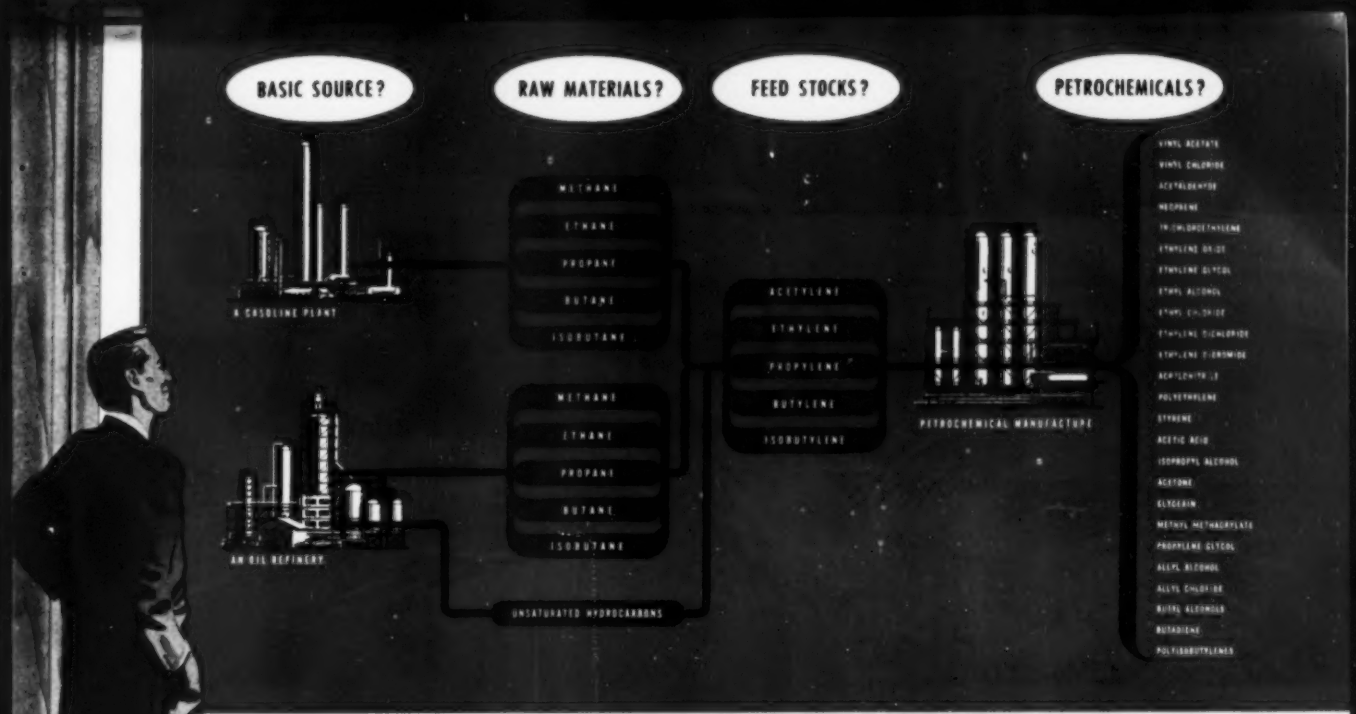

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Petrochemicals, the largest new factor in our ever-expanding world of chemicals, now account for nearly one-quarter of all U. S. chemical production. Despite this, it is estimated that only one-half of one percent of all present oil and gas production is being utilized as petrochemical feed stock. This opens up new opportunities for the oil and gas producer and investor.

If you own, operate, or have interests in an oil refinery or a gasoline plant, you should be aware of *your* potential as a supplier of petrochemical raw materials. This is particularly so when it is considered that the increase in value of an end petrochemical product may easily be four or five times greater than that of normal products realized from other hydrocarbon processing operations!

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The proven abilities to design, engineer and construct complete plants and facilities for the petroleum, natural gas and petrochemical industries have established The Fluor Corporation as one of the nation's major engineering and construction organizations.

One call to Fluor will place men with broad and diversified experience in petroleum and chemical engineering technology and economy at your disposal. Let Fluor put these talents and facilities to work for you. You will be sure with Fluor!

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Recommendations—From all data, Layne recommends an overall plan for the best development or expansion of a water system geared to your situation and needs.

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Specify a 100% Layne Well Water System

In a Layne water system, the name of the world's most experienced water developer stands behind everything—engineering, labor, wells, casings, screens, pumps. One contract assures you the finest in men and materials—and an undivided responsibility that assures your water supply.

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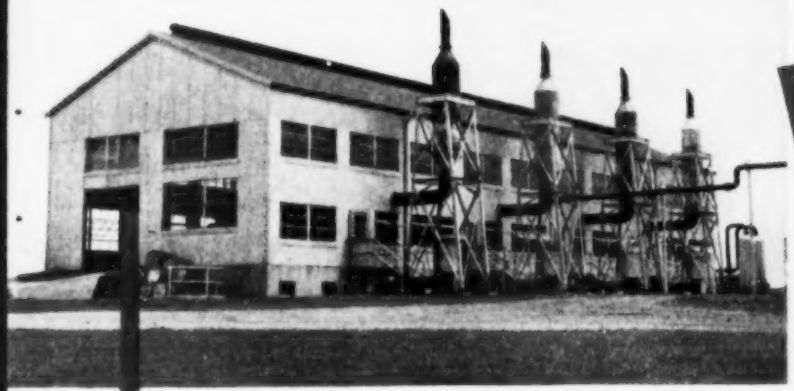
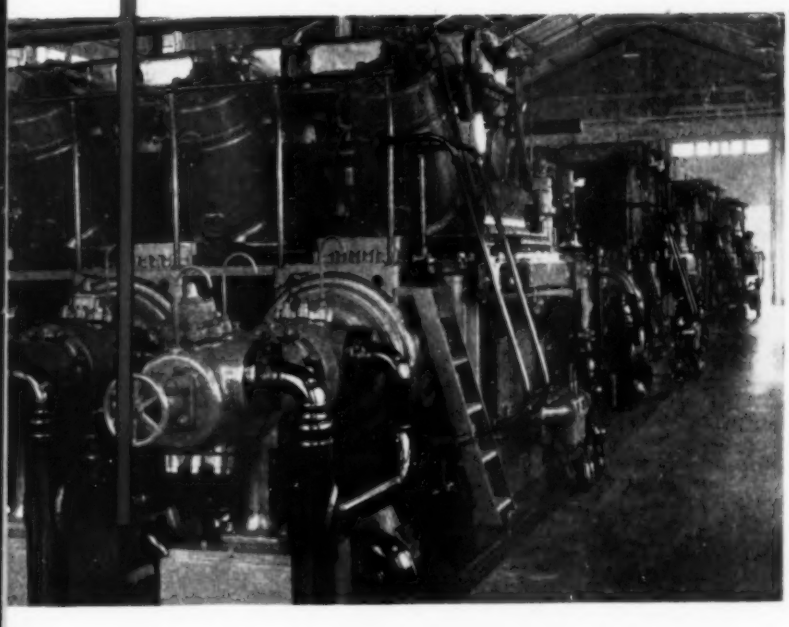
■ For Layne's catalog on Well Water Systems or other information, see your nearest Layne Associate Company or write to Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

Water Wells • Vertical Turbine Pumps • Water Treatment



Another Example of Efficient Power at Lower Cost

Cooper-Bessemer GMV'S



help East Ohio Gas put on the pressure!

THE East Ohio Gas Company reports excellent low cost service and exceptional fuel economy from their 4-unit installation of GMV compressors at the Robinson Station, shown above. Here, gas from the Big Inch and West Virginia fields is either compressed for underground storage or further boosted in pressure to supply gas to the industrial Cleveland, Akron, Canton, and Youngstown areas.

During extreme cold weather peaks when the pipe line supply is insufficient, the gas is withdrawn from storage and boosted on to the same industrial areas. The four GMV's installed in 1949 are 10-cylinder, 1100 hp turboflow units each with 5 compressor cylinders. The unique cylinder arrangement, utilizing each crankthrow, permits the engines to do three jobs at full load, boosting to market, pumping into storage, withdrawing from storage. Some 60 million cubic feet of gas is handled daily, from approximately 400 pounds suction to 1,180 pounds discharge.

Whether your plans call for complex compressor service, or the simplest kind of setup, you'll be ahead with Cooper-Bessemer V-angles. Check with the nearest Cooper-Bessemer office for the latest details.

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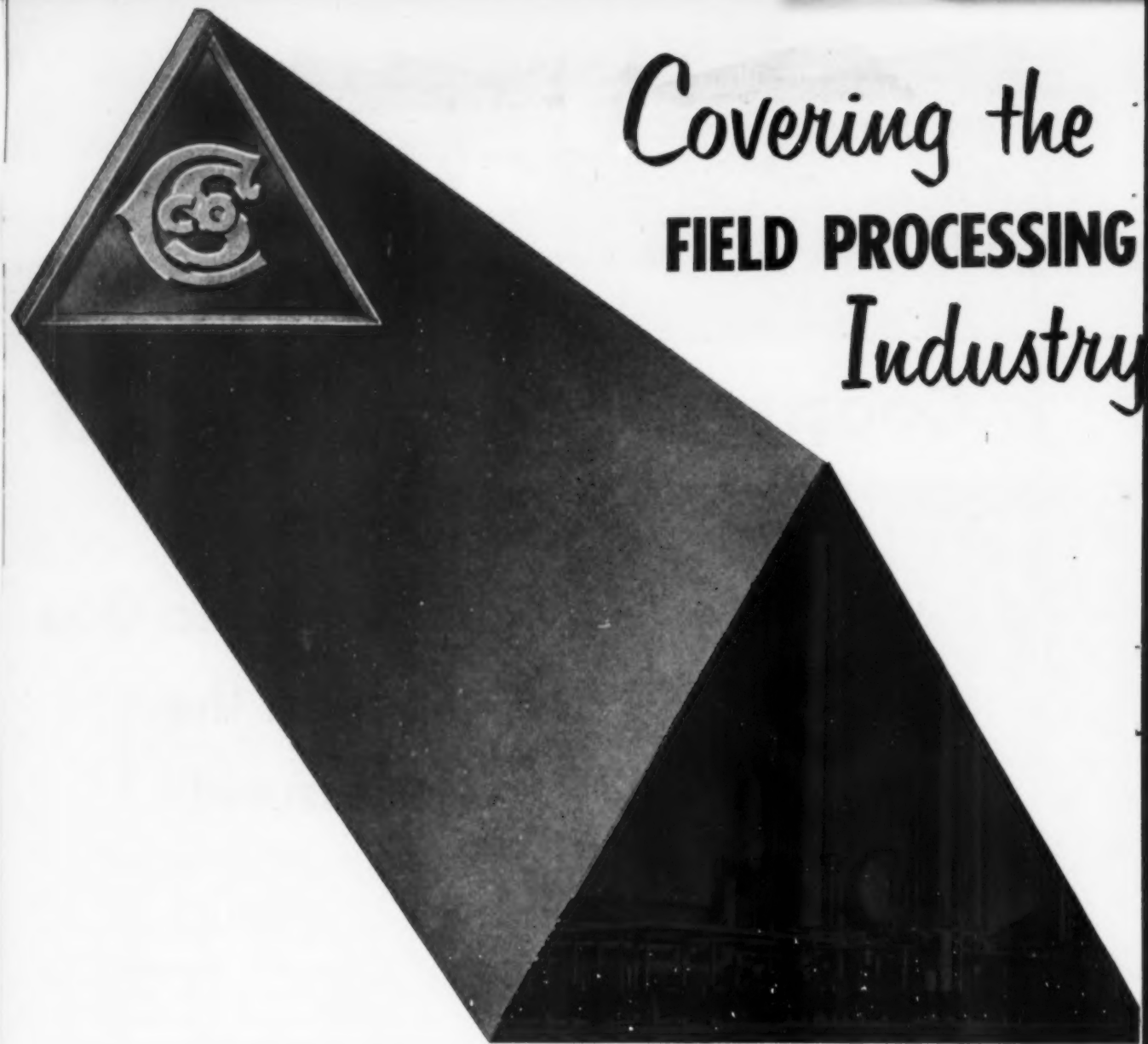

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During the year, many employers will be "guilty" of failing to set up a Safety Program. Of course, these employers do realize the great value of a Safety Program in saving lives and limbs . . . in conserving manpower and reducing insurance costs . . . yet often they just don't take the time to plan and install a Safety Program . . . or they fail to give the Program they do have, their support.

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SCRAPED SURFACE *Exchangers*

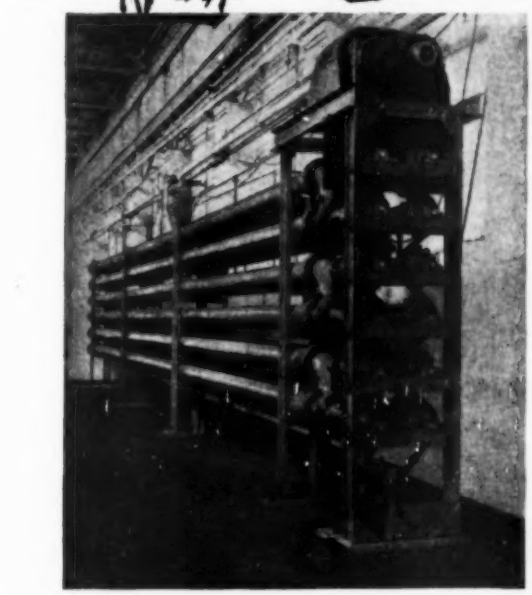
IF you are all "gummed up" with a tough heat transfer problem, Vogt Scraped Surface Exchangers will provide the answer. They have patented scraper elements which prevent fouling of the heat transfer surfaces and insure the highest rate of heat exchange between the product and the cooling or heating medium. The scrapers also continuously agitate the fluid and assist removal of solids from the unit.

DOUBLE PIPE EQUIPMENT is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

SHELL AND PIPE TYPE UNITS are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

Write for Bulletin PE-1



*DOUBLE PIPE UNIT. Drive and close-up of 12 section unit under test in our shop.

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H.P. pipe gaskets like these *made to your order* by gasket specialists...

...to save you both time and money

When you need metallic gaskets for high pressure piping, put the job up to Johns-Manville Goetze Gasket specialists. You benefit in many ways:

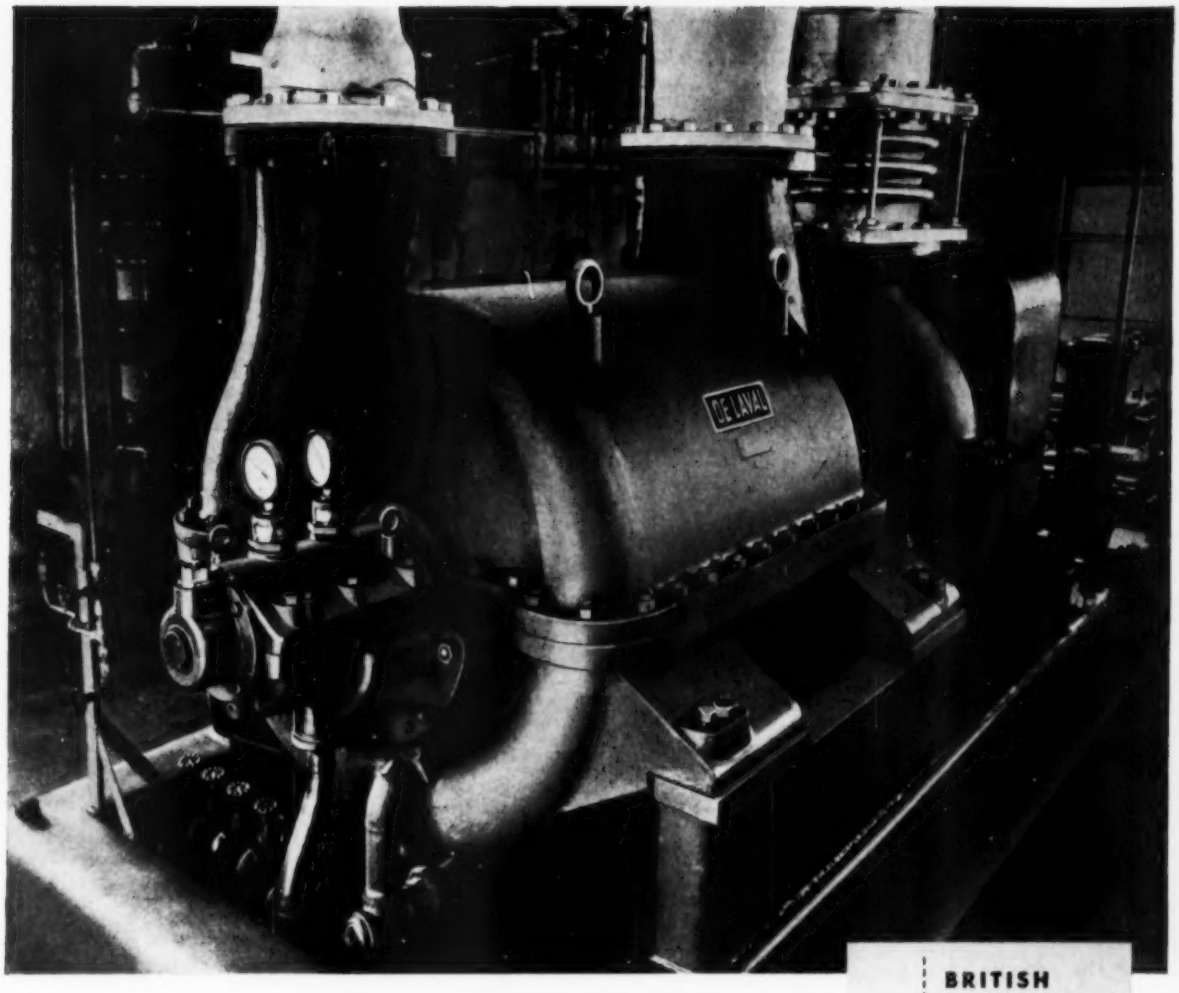
You get the exact gaskets you need for maximum efficiency under *your* operating conditions, tailor-made to fit *your* equipment. You get the savings in cost made possible by intensive specialization and modern production tooling. And you get the full benefit of over sixty years' experience in designing specialized metallic gaskets for industry's most complex sealing requirements.

Typical styles of Johns-Manville Goetze Gaskets that have been made to order for high pressure piping service are shown above. The flare type gasket with bellows action and the solid flare type are particularly suited for pressures above 5000 psi; the profile and V-Tite gaskets are generally used for lower pressures. Each of these is fabricated to extremely close tolerances. Other styles can be made to any desired cross section to meet your individual requirements.

For more information about Johns-Manville Goetze Gaskets, write for your copy of Catalog PK-35A. Or send us your drawing or template for an immediate quotation. Address: Johns-Manville, Box 60, New York 16, N. Y.

Johns-Manville *Goetze* GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE



This blower never takes a "breather"

at BRITISH AMERICAN OIL COMPANY

The clock never stops on this De Laval catalytic cracking blower in the Edmonton, Alberta plant of the British American Oil Company. Twenty-four hours a day this 885 hp, 8,250 cfm unit handles air for the regeneration of the spent catalyst.

There are good reasons for this power-saving dependability. This heavy-duty machine is built to take punishment. Its rugged casings, husky, perfectly balanced rotor and externally mounted, cylindrically seated bearings are design features that reduce maintenance and insure long, continuous service. Remember, there's no divided responsibility—both turbine and blower are De Laval designed, and De Laval made.

De Laval blower experience covers a wide range of industries—steel, refining, metal mining, chemical processing, high pressure gas transmission, manufactured gas, sewage aeration and many others. And all this engineering and manufacturing experience is ready to solve your specific blower application. Discuss it with a De Laval representative.

Send for Bulletin 0500 containing complete data

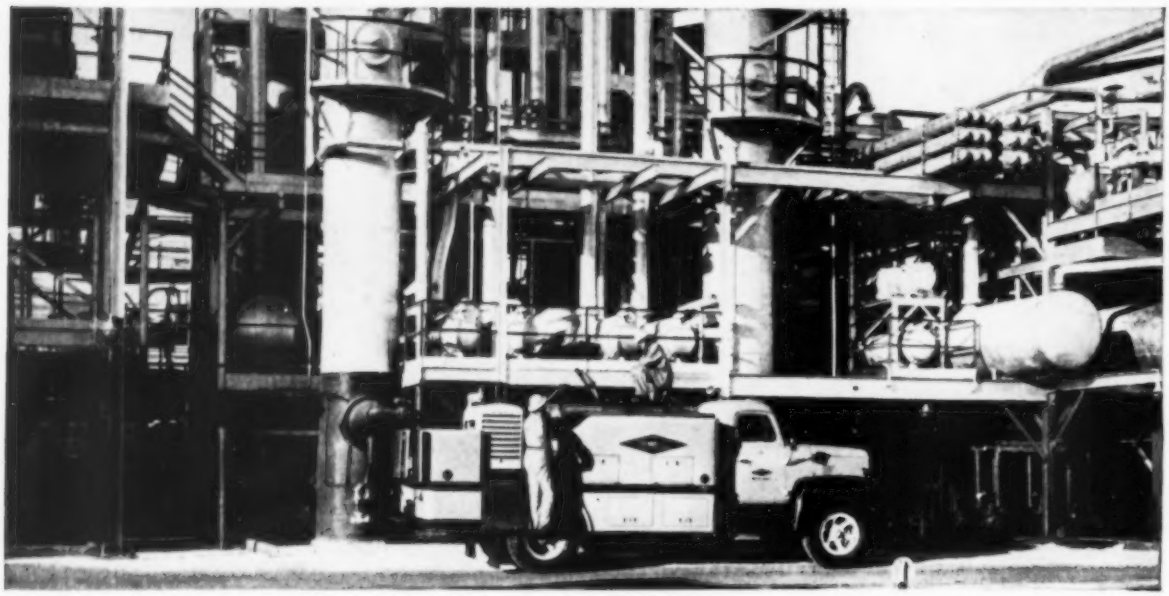
DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL 189

TOWER CAPACITY RESTORED IN ONE DAY BY CHEMICAL CLEANING

Through-put increased from 500 to 800 gallons per minute by Dowell Service



The capacity of a fractionating bubble-cap tower, operated by a southern chemical company, had dropped from 800 to 500 gallons per minute. Heavy deposits covered the traps and clogged the bubble-caps. Dowell engineers analyzed these deposits and found them to be iron sulphides, oxides and organic material.

Dowell Service removed these deposits from the tower in only one day with specially prepared liquid solvents. Result: the tower was restored to its original 800 g.p.m. capacity.

In the Dowell method of chemical cleaning, solvents are applied according to the technique demanded by the job: filling, spraying, jetting, cascading or vaporizing. Being liquid, they will go wherever steam or water will flow, reaching surfaces inaccessible to other cleaning methods. No special scaffolding is required. Dismantling and downtime are kept to a minimum. Experienced Dowell engineers do the job for you using Dowell-designed pump trucks and control equipment which are brought right into your plant.

Towers are just one of hundreds of pieces of industrial equipment which can be cleaned chemically by Dowell Service. For complete information and estimates on the cleaning of your equipment, call the nearest Dowell office, or write directly to Tulsa, Dept. H-31.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

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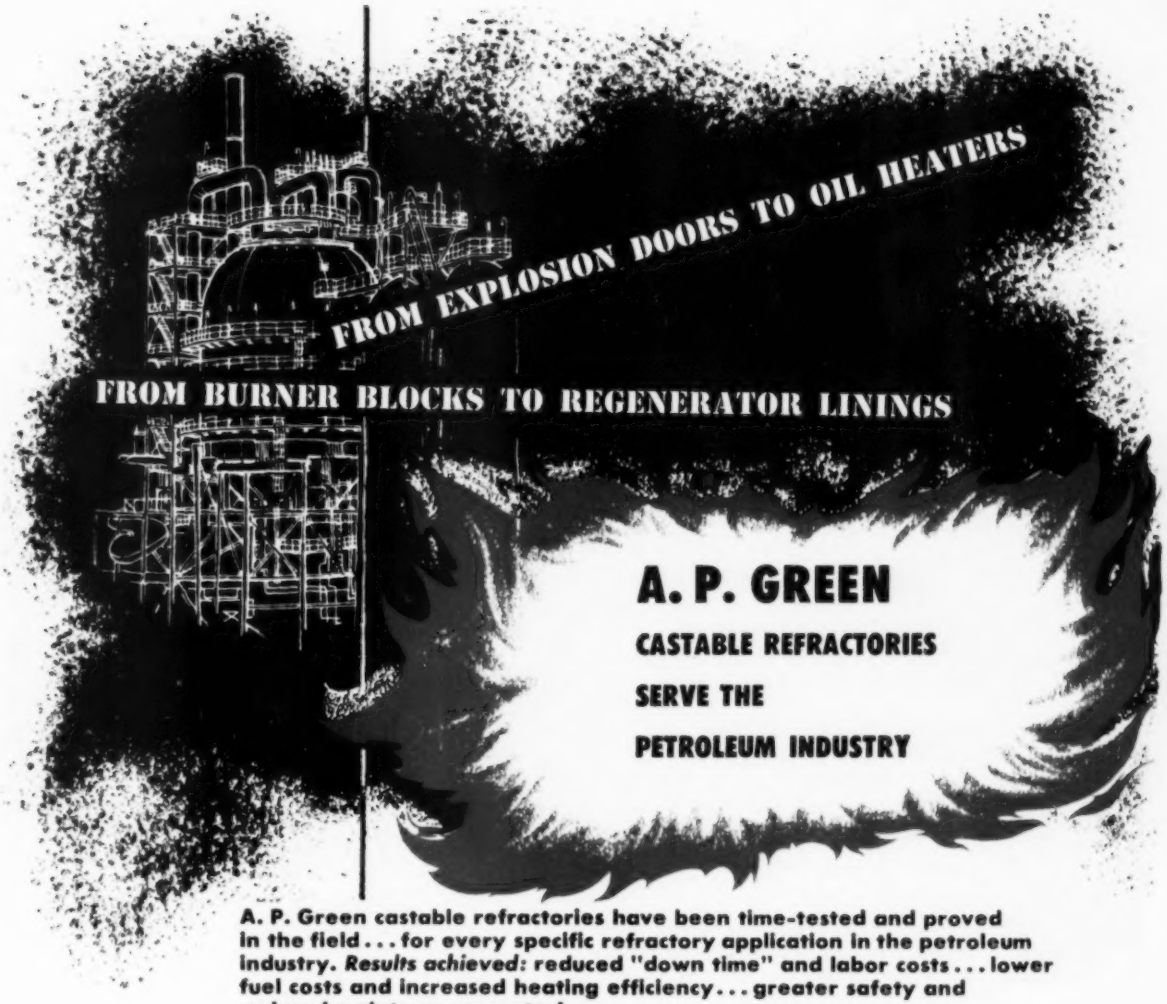

A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.

For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.

A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

KAST-SET — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

KAST-O-LITE — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

CASTABLE INSULATION NO. 20 — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

CASTABLE BLOCK MIX — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

CASTABLES FOR GUN APPLICATION . . . SK-7 — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

KS-4 — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

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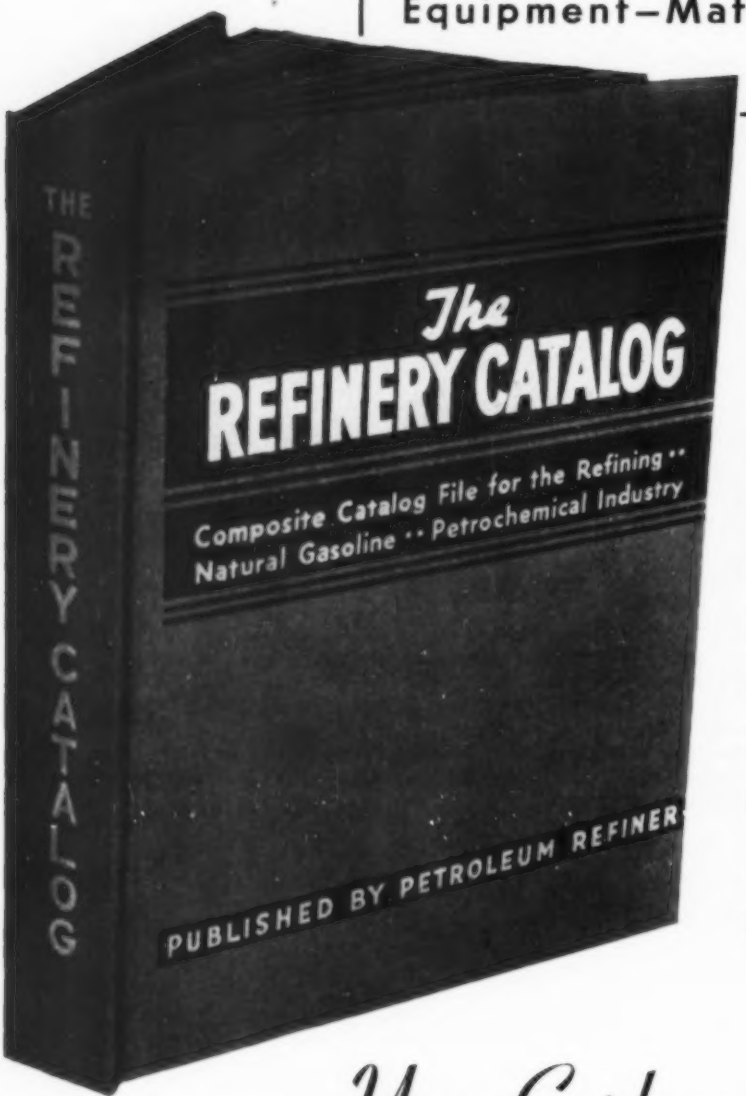
BASIC SOURCE BOOK

for

REFINING INDUSTRY

Equipment–Materials–Processes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Composite Catalog File for the Refining •• Natural Gasoline •• Petrochemical Industry
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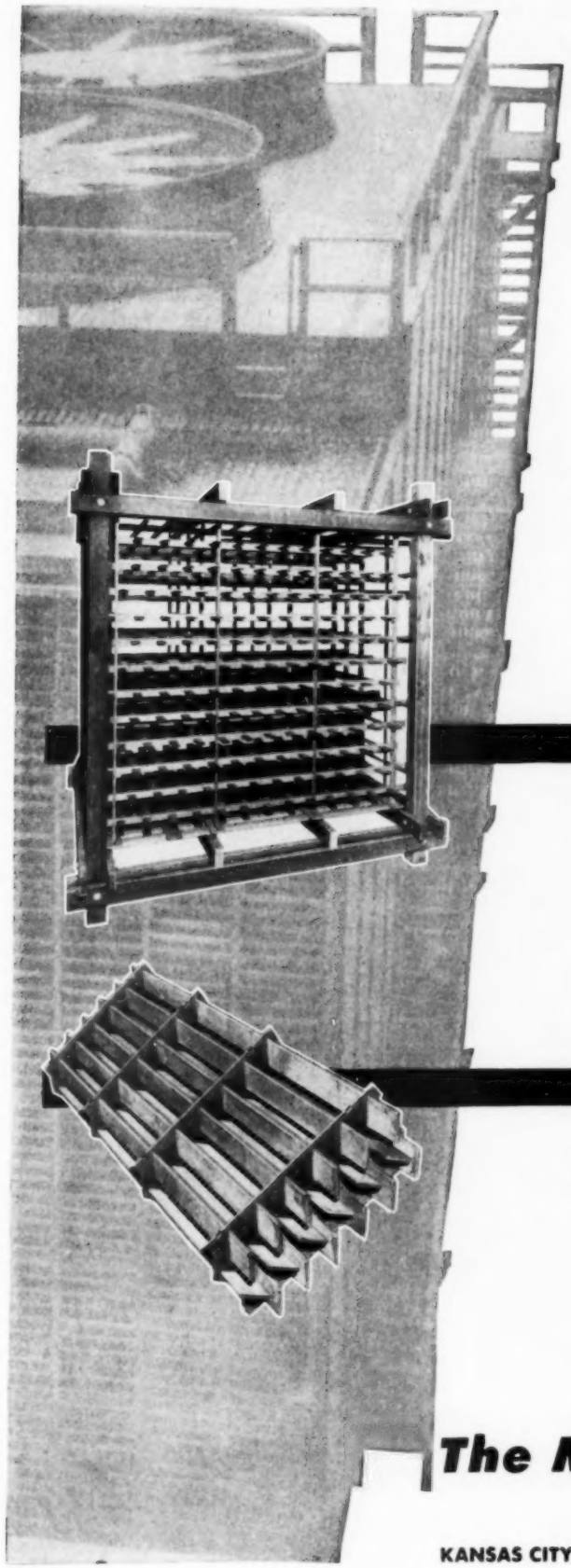

MARLEY design features that mean GUARANTEED PERFORMANCE

What cooling tower purchasers actually buy is ability to meet specific operating conditions. Sturdiness of structure and mechanical excellence dictate the life of the tower, but design alone affords the inherent ability to provide the necessary heat dissipation each process requires. That's why every Marley cross-flow tower is guaranteed to deliver design performance at all times, for only Marley cooling tower design incorporates such advanced features as:

MORTISLOCKED FILLING

This patented Marley filling breaks up the water at every six inches of fall and affords surface retention for longest air-water contact far greater than any other type filling. It achieves this top efficiency while offering absolute minimum obstruction to air flow. Add it up: most frequent water break-up *plus* greatest surface air-water contact *plus* lowest static pressure . . . and you have *peak performance.* MortisLocked filling has no corrosive fasteners to rust or corrode. It can expand and contract freely without warping or sagging.

TRIPLE-EFFECT DRIFT ELIMINATORS

Originally designed by Marley, triple-effect drift eliminators can be used with true efficiency only in Marley cross-flow towers. Position in the tower is of utmost importance for this type eliminator. As an integral part of Marley design, it is placed to best advantage to eliminate the largest quantity of moisture from entrained air without creating undue pressure drop. Marley cross-flow design utilizes 20 per cent greater eliminator area with resultant economy in draft loss and minimized drift.

The Marley Company

KANSAS CITY, MISSOURI

MARLEY

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TRECO's knowledge of refinery construction problems has been gained through the actual building of many Catalytic Crackers and other refinery facilities, throughout the United States and Canada.
Let TRECO's experience work to *your* advantage and profit! When TRECO moves in to build new facilities or modernize old ones, they waste no time. That is the reason most all TRECO jobs have been finished long before the completion date. This means the units will pay out more quickly due to TRECO's faster construction.
If you plan a new refinery or a modernization job on an old one, be sure to phone, or write TRECO before your plans are made. It can save you both time and money.
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REFINERY ENGINEERING Company
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The **Mail** Box

Fine Relationship

Dear Editor:

Your handling of my article "Where is Canada Going in Petrochemicals?" (page 89, July issue of PETROLEUM REFINER) deserves commendation.

It has been a pleasure to work with your staff, even at long range. I hope this will be the beginning of a fine relationship between us. Thank you for your splendid cooperation.

Eugene F. Gibbons,
Designers for Industry, Inc.,
Cleveland, Ohio.

Editor's Note—We hope it's the beginning, too, Author Gibbons.

PR Generates Action

Dear Editor:

Many thanks for printing my paper on the entrainment problem in the July issue of PETROLEUM REFINER. All of us here in the office were much interested in seeing it. I got a particular kick out of the way you handled my biography—or rather the lack of it.

I know you will be interested, and should be pleased, to know that I have already received from the..... Corporation a letter dated July 14 (Ed. Note: publication date was July 12). Certainly this is one proof that the REFINER is read and read quickly, and that it generates action!

Sanford C. Reynolds,
Metal Textile Corporation,
Roselle, New Jersey.

Like May Issue

Dear Editor:

A number of our engineers have been impressed by the editorial contents of your May issue.

Specifically they particularly liked the article entitled "Are You Lubricating Motors Properly?" starting on page 127; "What Is 'NPSH'?" starting on page 162, and the "Vapor Pressure of Water and Temperature Conversion Chart" on page 173.

Would it be possible to obtain 12 copies of each of these articles for our engineers' files?

Allis-Chalmers Manufacturing Co.
H. C. Brunner
Advertising and
Industrial Press,
Milwaukee.

Speaks With Authority

Dear Editor:

My attention has recently been called to your excellent little booklet, "How Petroleum Refiner Articles Are Selected and Should be Written." It contains many things which I, as a teacher of writing, have been trying for some time to get across to my students. Since some of my students are chemists and engineers, your booklet speaks to them with more authority than a mere pedagogue can muster. I should, therefore, very much like to have a copy and shall be most grateful if you can send me one.

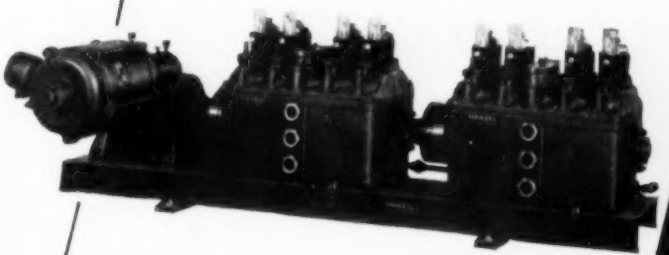
John E. Jordan
Assistant Professor of English
University of California
Berkeley 4, Calif.

HOW TO CURE

"Fluid-Feedosis"*

A CASE HISTORY

PROBLEM: Chemical Companies needed really dependable equipment for high pressure lubrication of compressor cylinders and bearings.



SOLUTION: Manzel developed a completely new line of heavy duty Force Feed Lubricators that pump S. A. E. 40 oil at pressures up to 30,000 PSIG. Enthusiastic reports of performance are being received from users.

*Difficulties in pumping chemicals, oils, and other fluids in accurate quantities for lubrication, chemical treating, or other purposes.

For the solution to lubrication difficulties, or chemical feeding problems, more and more companies are turning to Manzel. For 50 years a leader in the field, Manzel is today a flexible, fast-moving organization with the special technical skill for meeting *your* needs quickly and economically. Write for further information about Manzel Force Feed Lubricators and Chemical Feeders.

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Safeguard high priced machinery with MANZEL FORCE FEED LUBRICATION.

- Reduce Wear
- Prevent Breakdown
- Slash oil consumption
- Insure Round-the-Clock Operation

A DIVISION OF FRONTIER INDUSTRIES, INC.

How DuPont Fuel Oil Additive No. 2 can help you

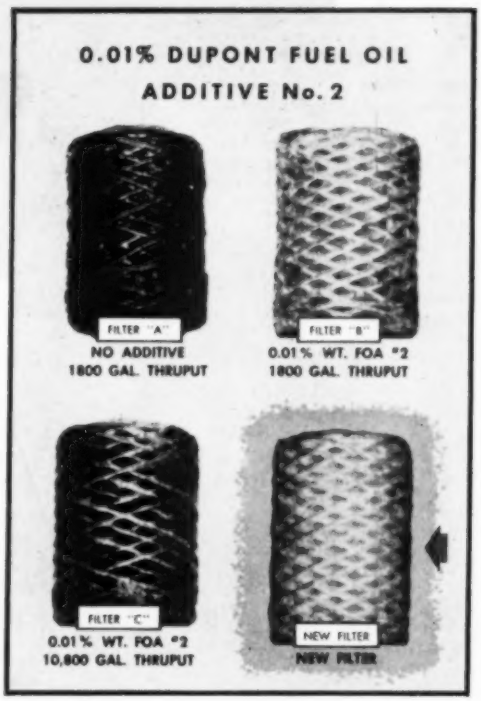
Cut servicing costs and increase your share of the *heating oil market*

With the trend toward a buyers' market in fuel oil, customer satisfaction is of increasing importance.

Now you can help eliminate customer complaints and bothersome service problems caused by plugged filters, screens and fuel lines . . . with Du Pont Fuel Oil Additive No. 2. This new ashless additive not only retards the formation of insoluble residues, but also reduces the particle size of the insoluble residues that *are* formed.

THE FOLLOWING TEST, conducted by a major oil company, shows the effectiveness of this new additive. During the 1951-52 heating season under actual operating conditions with domestic oil burners, approximately 70,000 barrels of a cat-cracked and straight-run blend were treated with Du Pont Fuel Oil Additive No. 2 at a concentration of 30 lbs. per 1000 barrels or 0.01% by weight. The fuel was of uncertain age when the additive was introduced and had the following average properties: 0.21% S; 326°F.—I.B.P.; 598°F.—90%; 654°F.—E.P.

None of the customer burner units used in the test were given any special cleaning or reconditioning beyond normal routine servicing. For a control, a similar marketing area was supplied with the same fuel—without the addition of Fuel Oil Additive No. 2.



TYPICAL RESULTS of this test are shown in the photograph on this page. The filters are from a commercial burner consuming about 1800 gallons per month. Prior to the start of the test, this burner had required filter replacement each month. But when operated on the fuel containing 0.01% of Du Pont Fuel Oil Additive No. 2, the filter and burner remained unusually clean and serviceable after a 10,800 gallon thruput.

EVEN BETTER RESULTS could have been expected in this test if the Fuel Oil Additive No. 2 had been added to *freshly prepared* fuel.

SAMPLES and a descriptive booklet on Du Pont Fuel Oil Additive No. 2 can be obtained from any Du Pont Petroleum Chemicals Division district office.

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The Look Box

What Is the Immediate Future of the Petroleum Industry?

Ray L. Dudley, Publisher, and **John J. McKetta, Jr.,** Editorial Director

The refining, petrochemical and natural gasoline industry spent in excess of $3 billion in capital investment alone from 1946 up to June, 1952. The refining industry alone will spend more than $700 million for new construction from June, 1952, to December 31, 1954. Oil industry process plant construction activities and thru-puts are continuing and will continue at high rates, requiring heavier replacement and usage in connection with operation and maintenance.

This heavy demand for the next 18 months will come from . . .

- New construction to meet present decisive trends in the manufacture of gasolines of higher octane ratings. This improvement involves construction of additional new catalytic cracking and reforming units in both established and new plants.
- Urgings by the U. S. Government that a greater *surplus* refining capacity be built.
- Revised construction program based upon the creation of new refining centers because of changed economic conditions. (As an example . . . refineries in the northwest U. S. A. to handle new supplies of Canadian crude—probably a definite trend for some time to come.)
- Construction of additional petrochemical plants because of markets afforded for new products.
- Construction of new gasoline plants because of the nature of the new fields being discovered.
- Operation and maintenance of the greatly expanded capacity of plants of the type indicated.

Product Demand— The civilian and military uses combined will increase the U. S. domestic demand for oil products in 1953 about 6.5 percent over that of 1952. This is an increase of approximately 32 percent in the past four years. The yearly increases are as follows:

Year	Increase
1950	12 percent
1951	10 percent
1952	3.6 percent
1953	6.5 percent
1954 (estimated)	5 percent

The average daily demand for all U. S. oils in 1952 hit an all-time high of 7,850,000 barrels per day. *This was twice the demand of 1940.* The U. S. Government wants the oil industry to have a reserve refining capacity of at least 1.5 million barrels per day instead of the present 0.6 million barrels per day reserve capacity. Therefore, including the government's desires, the refining capacity will exceed 8.4 million barrels per day by the end of 1954.

Future Demand Astounding—Authorities agree that the U. S. demand in 1975 will be *doubled* over that of 1950. At the same time, the world demand will be *quadrupled* over the 1950 demand. This rapid expansion of demand is the background against which refiners must adjust their plans for 1954 and the years beyond. This means astounding expenditures for refining capacity increases abroad.

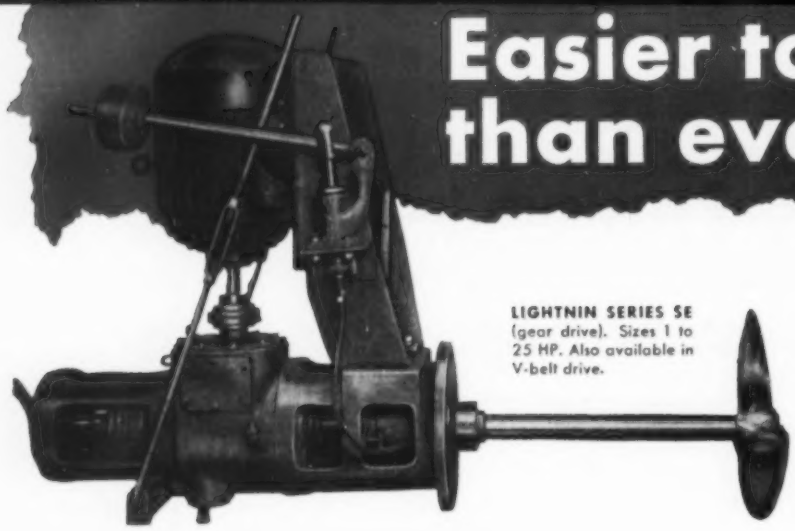
Aviation Gasoline—The Petroleum Administration for Defense figures show aviation gasoline is short 30,000 barrels per day. The government wants industry to increase the alkylation capacity. The demand for aviation gasoline will keep rising at least four or five years, even though the use of reciprocating engines is on the down grade.

Petrochemical Industry— *Today almost 50 percent of all organic chemicals made in the U. S. are based on petroleum.* Petrochemical production has grown from 1.9 million tons per year in 1946 to the almost unbelievable figure of 8.5 million tons estimated in 1952. By 1956 an increase of 32 percent over 1952 will be seen. That is not sufficient. It is expected that petrochemical production will reach 32 million tons in 1962. Of the total chemical sales of $18 billion in 1952, about one-sixth of this was for petrochemicals.

The capital investment in these plants rose from about $330 million in 1942 to $2000 million in 1952. In 1962 this figure is expected to exceed $7000 million. Early in 1952 there were 100 plants producing petrochemicals, 50 of these were in the Gulf Coast area. Today there are over 50 percent more petrochemical plants. At the present time there are $750 million worth of expansion in actual construction and planning stages.

Natural Gasoline Industry—Between 1953 and 1956 there will be approximately a one billion dollar expansion of natural gasoline plant facilities. As oil is found at increasingly greater depths, the character of the hydrocarbon fluid produced frequently differs from that found at shallower depths. Instead of oil of the former "normal" gravities, distillates in gas form are found in more and more fields. This condition, plus LPG products, plus the further fact that demand for natural gas had risen enormously, (and natural gas *should* have certain hydrocarbons removed to make it more efficient) is having and will have substantial effect on the construction of not only more gasoline plants, but more complicated and larger plants than in the years past. (According to Barrons, the 1952-56 period will see $4.5 billion spent for gas lines alone.)

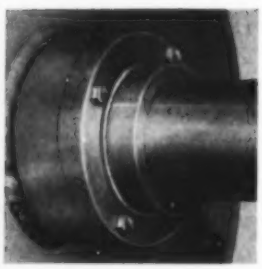
Easier to repack than ever before



LIGHTNIN SERIES SE (gear drive). Sizes 1 to 25 HP. Also available in V-belt drive.

No wrenches needed to shut off stuffing box from tank contents

TO SHUT OFF WITH TANK FULL, operator loosens a set screw and turns handles on bronze housing. It's as easy as closing a valve.



INSIDE THE TANK, a Teflon gasket is compressed between the seal collar and end cap. This positively seals off tank contents.

TOP ENTERING turbine and paddle type mixers for open or closed tanks. Sizes 1 to 500 HP.

LIGHTNIN PORTABLE MIXERS ... Used everywhere for hundreds of fluid mixing jobs. Thirty models to choose from. Sizes ⅛ to 3 HP.

These two new LIGHTNIN Side Entering Mixers cut maintenance time in half, they're so easy to service.

When stuffing box needs to be repacked, your maintenance man just loosens one set screw. Then he easily shuts off the stuffing box from tank contents, by rotating the outboard bearing holder, which has two easy-to-get-at handles.

Returning the mixer to operating position is just as easy and foolproof. You've never seen anything so simple and slick in a side entering mixer.

This is just one of the features that will sell you on these new LIGHTNIN Mixers. Others are:

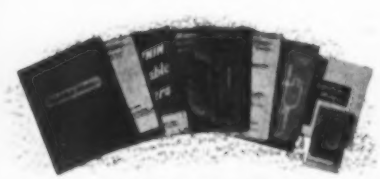
Your choice of stuffing boxes or mechanical seals to fit the mixing job.

Smoother operation because new vertical motor mounting (on gear drive units) moves center of gravity closer to tank, minimizing vibration.

Full guarantee says the mixer will do the job and do it *right,* or your money back.

Specify the new LIGHTNIN Mixers for gasoline blending, lube oil blending, sediment control—and wherever there's a *big* mixing job that must be done right. Call your MIXCO representative today, or write us for details.

Lightnin® Mixers



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The **Look Box** for August

Crude Price Increase Justified

THE RECENT increase in the price of crude oil is fully justified and should receive the support of every thoughtful American.

This is the opinion of C. H. Lyons, president, Independent Petroleum Association of America. Continuing he cited these facts:

"Prior to the recent increase in price of approximately 25 cents per barrel, there had been no advance in the price of crude oil since December, 1947—a period of five and one-half years—while the price of practically all other commodities increased sharply. But the cost of finding and producing oil increased substantially during that period. Labor and finished steel products, for example, are both up 40 percent and the price of oil field machinery has increased 30 percent. The latest increase in the price of steel is not reflected in these percentages. Moreover, the average depth of wells drilled today is 659 feet deepr than in 1947.

"Qualified authorities estimate that there will be an increase of 100 percent in the peace-time demand for oil in the United States during the period 1950 to 1975. This means that by 1975 the industry should double its present productive capacity. The industry must expend tremendous capital sums to meet this challenge. Only by meeting the challenge can the industry continue to supply consumers with an abundance of petroleum products at reasonable prices.

"Our present capacity to produce oil is inadequate to meet the emergency needs of the Nation. This fact was established not by the industry, but by governmental authorities. Those authorities have called on the industry to drill 55,000 wells in 1953—nearly 9000 more wells than were drilled in 1952—to assure an adequate supply of oil within our own borders to meet any emergency. But the industry has been unable to reach that rate of drilling with the capital which has been available to it.

"In fact, unless the current rate of drilling is accelerated, the total number of wells drilled this year will not exceed some 46,000—about 9000 less than the required number.

"There is no doubt that undiscovered oil exists in this country in sufficient quantities to meet our petroleum needs in peace and war, in the foreseeable future. The United States contains one billion acres of potential petroleum land. Not more than one percent of that acreage has been fully developed. Thus, a vast domain remains to be tested. It is only necessary to drill the required number of wells to find the needed oil in the United States. Domestic oil is the only oil we can realistically rely on in the time of emergency.

"The recent price increase provided additional capital and incentive for accelerated drilling, but is inadequate in relation to the vast number of wells which must be drilled to meet the petroleum needs of the nation."

New Tariff Law Needed

REVISION of United States' tariff laws to promote freer world trade was urged in a recent address by T. S. Petersen, president of Standard Oil Company of California.

"The new law should allow for adjustments in the rate of reductions to soften the hardship in particular cases, but it should at the same time move the country steadily toward the goal of open competition with all comers," he declared.

"The prosperity we create by buying abroad will enable new millions of people to buy our products who have never bought them before. The dollars we spend will come blowing back with handsome interest.

"And with these dollars will come the the good will and respect of all those who benefit from the policy. The value of that good will and respect at this time of our history is obvious to every thoughtful American."

Petersen declared that the United States had the chance to offer the freedom and opportunity on which its own progress has been based to other peoples, instead of continued foreign aid. He called the American traiff "a contradictory thing." While we have asked other nations not to trade with Iron Curtain countries we "have also denied them the right to sell in the only other place that could offer an adequate market for their goods—the United States."

More Realistic Tax Write-Off

SPEAKING FOR the Independent Refiners Association of America before the House Ways and Means Committee, Elmer E. Batzell offered three alternate methods to the federal government's present amortization schedule for investments. He criticized the present law as entirely too inflexible and went on to sum up his case as follows:

"One important thing seems highly desirable regardless of the method: That the rules as to accelerated depreciation be self-operating and without review by government in the selection of facilities to which the rules may be applied. It is the taxpayer rather than the government officials who is in the best position to estimate the useful life of the activity. Any system in which government approval of the facilities involved is required as a condition for utilizing the accelerated depreciation necessarily will result in government programming of industrial activities, inequities between applicants in the administration of rules and a premium upon know-how in obtaining government approval rather than know-how in operating the facility."

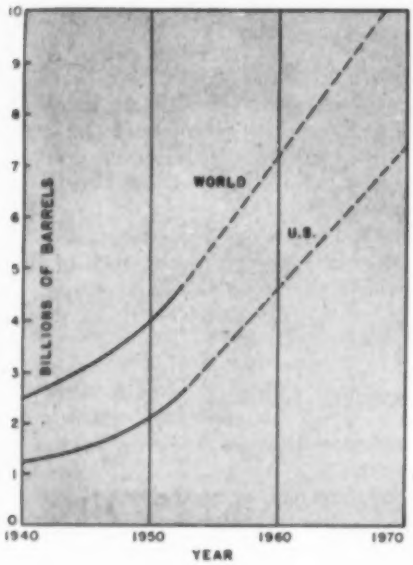

Figure 1. Demand for liquid fuel.

The long-range outlook for . . .

Liquid Fuels in America

As to the adequacy of petroleum, the picture shows these surprising facts:

• It makes little difference whether we assume 100 or 200 million barrels for ultimate U. S. reserves.

• World shortage seems to be roughly parallel to U. S. import needs.

Eugene Ayres
Gulf Research & Development Company
Pittsburgh

PROBABLY MORE people have made more predictions about the future of liquid fuel supply than about any other future circumstance. And more people have been proved wrong. Reasons for such thankless fecundity are that liquid fuel supply is of extreme importance to our economy, and that for many years rate of potential supply has been of about the same order of magnitude as rate of use. Thus we have an ideal subject for speculation, albeit a treacherous one.

The general impression in the public mind is that a contest has been under way between those who "view with alarm" and those who "point with pride." For the most part this is a mistaken impression. All who are well-informed are confident that liquid fuels will have a long and abundant life. All are aware of possibilities of improvement in technology of discovery of petroleum, of percentage of recovery, and of manufacture of supplemental liquid fuels. But all know that natural petroleum reserves in the United States and elsewhere are finite. All know that United States and world production can keep on rising for some indeterminate number of years but will then start to decline.

A confused impression has been created by use of words vaguely defined. By future do we mean 10 or 15 years, or do we mean a century or two? Are we talking about domestic petroleum, or are we including the portion of world petroleum that can be made available to us? Are we limiting our meaning to natural petroleum, or are we including shale oil and oil from coal? Do we go still farther afield and include oil from vegetation?

Original presentation was before the Second American Power Conference, Chicago, March 25, 1953.

What Is Abundance?

In January of last year a report was presented on "Petroleum Productive Capacity" by the Committee on Oil and Gas Availability of the National Petroleum Council. This report is commended for study because it represents conclusions of the most competent people in the petroleum industry. But it must be read with thoughful understanding. For example, a widely quoted and strongly emphasized phrase from this report is: —"crude oil and natural gas may be counted upon to be available in abundance for the foreseeable future." What is *abundance?* Does this mean more domestic petroleum at competitive cost than we shall need? Clearly it does not mean that, for we are importing petroleum more heavily every year. What is *foreseeable?* In a strict sense no part of the future is foreseeable. Does it mean *indefinite?* Clearly not, because production of finite reserves cannot be maintained indefinitely. What the phrase really means, I think, is merely that reserves are immense and that the time has not yet come to worry about them.

The conclusions reached by the committee for "long-term prospects" are quite general. Certainly no one could object to them. The sense of the report is summed up in the last sentence: "Our prospects are good for the discovery of petroleum and for ample supplies of *fuels generally* for the foreseeable future. The italics are mine.

An attempt shall be made here to provide a few structural bones for the amorphous body of prophecy. The structural elements will be logical rather than statistical. Instead of depending altogether upon tentative extrapolations of statistical trends I shall reverse the rational process by which paleontologists have attempted to encompass prehistoric skeletons with flesh and blood. Both reconstruction and preconstruction can be best accomplished by combining known facts with circumstances inferred from reason, imagination, and art. In this task, as in many others, art serves as a short cut for mathematical operations, and can be much more precise when important variables are unknown. The results of mathematical computations have only the validity of the framework of fact in which the computations are hung.

During the past 90 years, the world has depended almost exclusively upon natural petroleum for liquid fuel. Less than a tenth of one percent has come from oil shale and coal. The reason for this has been economic. As long as we have an adequate supply of cheap petroleum we shall not seek more expensive substitutes. The small amount of supplemental fuel so far used has been surplus benzol and tar from by-product coke ovens, and shale oil and fermentation alcohol produced as occasional slight gestures toward political expediency. How long will cheap petroleum be in adequate supply? The answer hinges on four numbers—supply and demand in the United States and supply and demand in the rest of the world. Whether a given supply is adequate or not depends entirely on demand. For a given demand, adequacy depends entirely on

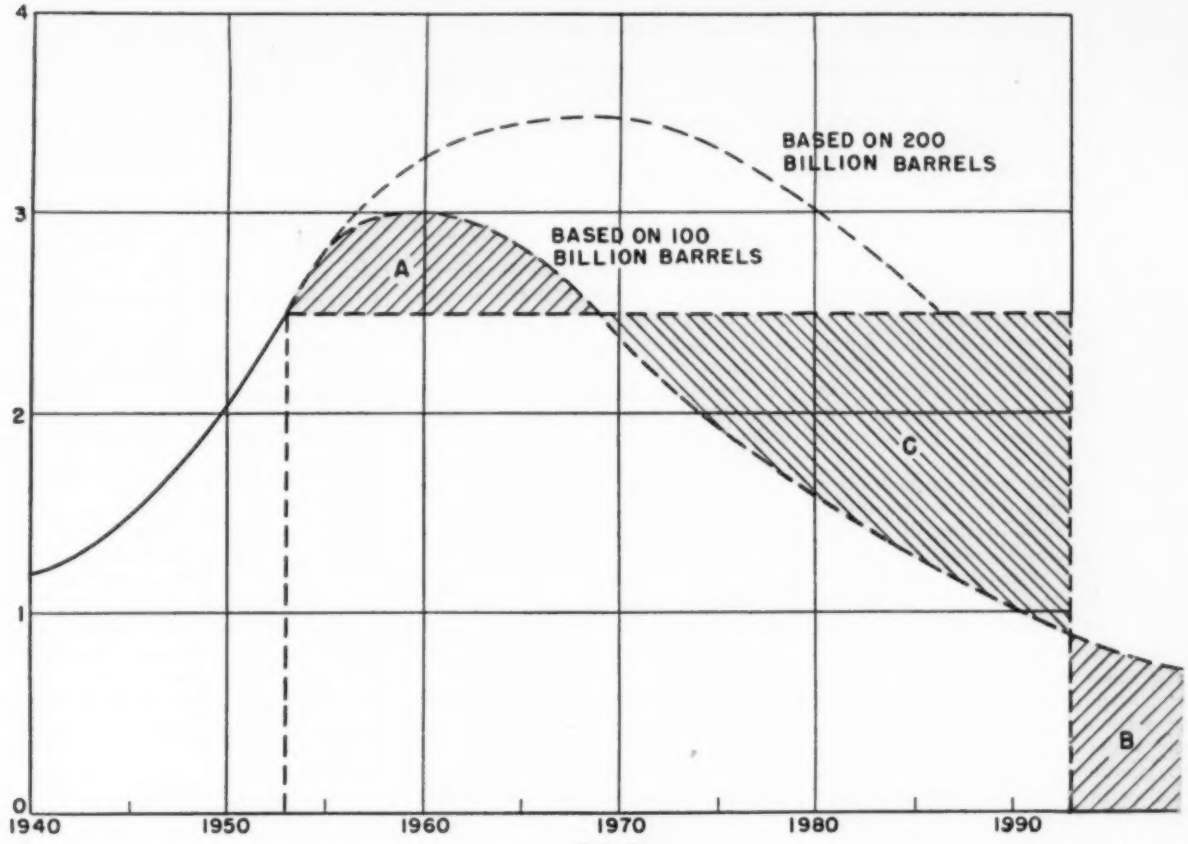

FIG. 2
RATE OF PRODUCTION OF PETROLEUM IN THE U.S.

Figure 2. Rate of production of petroleum in the U. S.

supply. Supply may come either from domestic production or from importable world surplus.

Now here we see a curious psychological phenomenon. Those who are most optimistic about supply are usually most pessimistic about demand, and vice versa. "Adequacy" is measured by the difference between supply and demand. Some of us tend to subtract relatively small numbers from relatively large ones. The rest of us are inclined to do the opposite. Thus it happens that oil men often seem to be somewhat more sharply divided than would otherwise be the case, and objective appraisal of future probabilities becomes extraordinarily difficult. The paleontologist can be more objective not because he is a better scientist but because he has no economic or social stake in the outcome of his labors.

Historically the course of events has shown that those who have been bearish on supply have been absurdly wrong. The same thing has been true of demand. You may recall that petroleum economists expected a 20 percent drop in motor fuel consumption for the first few years after World War II. Instead we had a 20 percent rise. In more recent years, economists have been stressing the importance of factors that should slow down the rate of increase of petroleum demand. Our highways already must contend with about 10 percent more vehicles than they were built for. Increased motor vehicle population depends on great capital outlays for new and better roads and parking facilities. It sometimes seems that nearly everyone has a car now and many have more than one. Railroads will be almost completely dieselized by the end of this year. Natural gas is making substantial inroads on domestic furnace oil sales. These and other factors seem to point not to reduced liquid fuel demand but to a sharply lower rate of increase. Our common sense tells us that the curve of demand for any commodity may finally tend to level off as markets approach saturation, and present circumstances indicate that for liquid fuel demand the leveling-off may not be far away.

Bearish Outlook Confounded

But such leveling-off has seemed imminent for the past 40 years. During all that time more conservative men have expected far less demand than actually developed, and even the more radical optimists have undershot the mark. Demand has always exceeded expectations. No one can possibly say how much longer it will continue to do so. But I believe that events will confound any bearish outlook until technology shall have substituted something better than liquid fuel for major applications. This assumes that we shall not have to face a drastic reduction in our scale of living. Statistical records indicate that the only leveling-off of demand for any commodity has been caused either by technical or economic obsolescence or by declining scale of living. Our scale of living is still rising and no hint of technical obsolescence has yet appeared.

We need not go back more than a few years for examples of over-conservatism. In 1950 an important address before the American Petroleum Institute contained the prediction that United States demand by 1960 might be "something over 8 million barrels a day." The Petroleum Administration for Defense in January of this year expects that our oil demand will be a little above 8 million barrels a day in 1953—seven years ahead of schedule.

EXCEPT FOR ship bunkers, residual fuel oil should gradually disappear as a fuel and should be converted, instead, into distillate fuels such as gasoline and oils for diesel and jet engines. Economics will take care of this. Liquid fuels will cost too much to be used in competition with solid fuels or natural gas. We shall look back on present fuel practices with mild amazement.

Early in 1952 I was criticized for assuming a United States demand as high as 8.8 million barrels per day in 1960. Now it seems that this figure will be more than reached in 1954.

Later in 1952 a prediction was made of 9.3 million barrels a day for 1960. It looks now as if this figure will be reached by 1955.

Such examples could be multiplied many times, but the most interesting thing about them is that the largest errors on the low side have been made by the best informed "authorities," and no one—not even the most poorly informed—has made an error on the high side.

Perhaps one good reason for this has been consistent under-estimation of demand for motor vehicles. Amazing under-estimation has been going on continuously for 50 years. For instance in 1934 an oil company forecast a 1950 car population that was reached, instead, in 1940. In 1950 an important oil company forecast a 1960 motor vehicle population that was reached in 1952. Clearly, we are not learning from past mistakes.

How about demand for the rest of the world? The rest of the world is increasing its consumption more rapidly than we are. The most obvious explanation is that the rest of the world has a far greater margin for technological improvement and for potential demand than we have. The rest of the world has a long way to go to catch up with us. In 1910 we consumed 21 times as much oil per capita as the rest of the world. The factor rose until the maximum distortion was reached in 1930 when we consumed 30 times as much per capita as the rest of the world. Since 1930 the factor has become smaller each year. In 1940 it was 26; in 1945 it was 22; now it is 16. So no matter how steep we draw the curve of United States consumption we must make the curve of world consumption even steeper.

These qualitative observations may be illustrated by Figure 1 in which demand is extrapolated to 1970. In spite of the lessons of the past I have not the courage to do more than draw straight lines from present trends.

These demand trends, for what they may be worth, give two of the numbers required for determination of "adequacy." A distinction should be made between demand and consumption. Demand will be the amount desired at a price. Consumption will be the amount actually used, and could be lower than "demand" to the extent that petroleum may be either unavailable or too costly.

The other two numbers required for determination of adequacy must come from expectations of supply. The supply of petroleum is, of course, not the volume of proved reserves or ultimate reserves but the rate at which petroleum can be produced. Many different statistical criteria have been studied in attempts to project rate of production. For example, rate of production has been related to rate of discovery, to number of wells drilled and to many other factors. I prefer to relate rate of production to the single factor of amount of ultimate reserves. Geologists have ways of roughly estimating the total probable reserve of petroleum in the United States and in the rest of he world. Whether the calculations are reasonably reliable will be known within a few years—long before the petroleum in the earth approaches exhaustion. We have here something definite to tie to—almost independent of rate of discovery, magnitude of discovery effort, improvements in technology, general business index, wars, or political upheavals.

A few years ago generally accepted figures of ultimate reserves were 100 billion barrels for the United States and 1000 billion barrels for the world. After it was shown (in 1952) that this figure for the United States meant a peak of petroleum production only a few years away, the data were re-examined, and various methods of extrapolation were studied in an attempt to arrive at ultimate reserve figures based on statistical trends. If it is assumed that the peak of United States production must come later than 1960, it is necessary to assume that our ultimate reserve is much larger than 100 billion barrels. One estimate, made in late 1952, is 120 billion. But even this cannot postpone our peak of production more than a few years. So some petroleum people are now talking about 200 billion barrels.

Such estimates include recoverable oil from off-shore pools. Newspapers have mentioned 100 billion barrels for these fields alone. Maximum actual recovery may not be more than a fifth of this and could be very much lower because of technological difficulties of recovery. Such difficulties can make an enormous difference. For example, the Spraberry field in Texas, covering more than five times as much area as the great East Texas field, is now showing only about a 10 percent recovery of oil. The other 90 percent is left behind—permanently.

The higher estimates of ultimate reserve are based, not on firm physical data, but on a rather passionate desire to postpone the time when oil production will be inadequate. The higher estimates may prove to be right. Within a decade we should know.

In Figure 2, production of oil in the U. S. is extrapolated to 1993 based on ultimate recoverable reserve figures of 100 and 200 billion barrels. You will note that doubling the reserve postpones the peak of production from 1960 to 1970. If the lower number is right, evidence should appear in three or four years in the form of somewhat less increase in production rate. Even if the higher figure is right the evidence should appear by 1960.

How High the Peak?

Reasons for drawing these curves as they appear in Figure 2 are pretty well known. For 100 billion barrels, a rectangle is shown with a side of 2.5 billion barrels (1953 expected production) and extending 40 years into the future. The area of this rectangle is 100. If the area under the production curve is to be 100, the sum of areas A and B must be made equal to C. The shape is rather indefinite inasmuch as the curve may be expected to approach zero almost tangentially after 1990. The last portions of our ultimate reserve are likely to be difficult to find and may be difficult to produce. This is an example of the substitution of art for mathematics. We cannot know how high the peak may be or how sharply the curve may drop after the peak. If the curve is made to look reasonable it is quite possible to adapt mathematical expressions to it and to determine, in this way, the peak dates corresponding to various ultimate recoverable reserve numbers. But mathematics are a lot of trouble and in the long run we must depend upon a good eye for shape.

These extrapolations are made without reference to rate of development or discovery of reserves. Since a definite relationship is known to exist between rate of production and magnitude of proved reserves, the shape of production curves must assume that

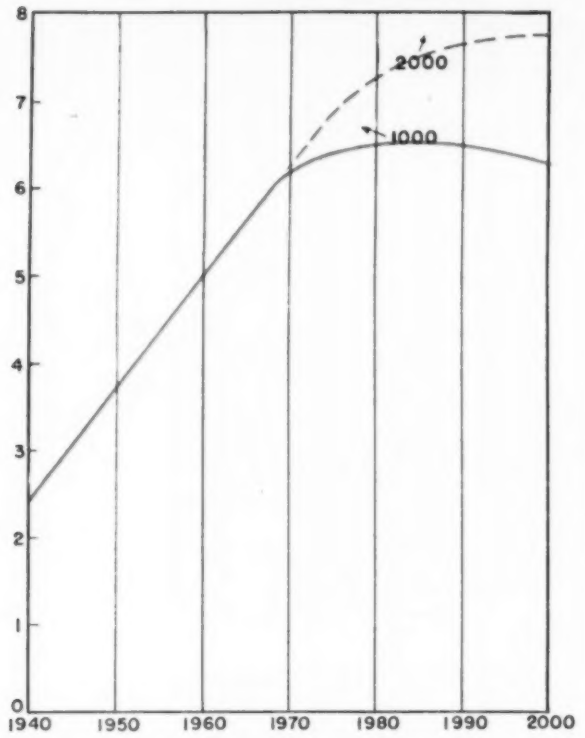

Figure 3. World petroleum production for 1000 and 2000 billion barrels of ultimate reserve.

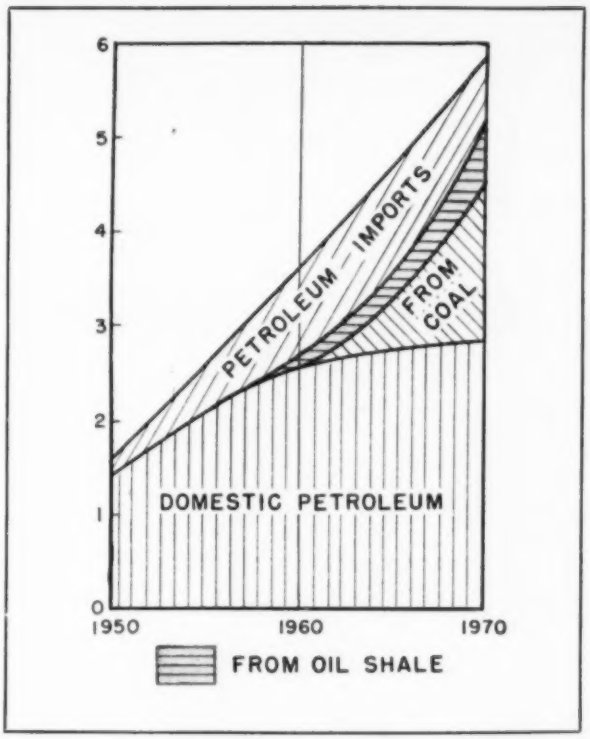

Figure 4. Production of distillate fuels.

reserves will be found at an adequate rate. It is interesting to consider what would happen if the proving up of reserves were to take place with abnormal rapidity or with abnormal slowness.

First, take the imaginary and impossible extreme in which, by the waving of a geophysical wand, all remaining oil reserves of the earth were discovered tomorrow. In such case, the only limitation to rate of production (aside from cost) would be rate of demand. Production might rise higher than shown in Figure 2, but then it would have to descend more abruptly.

The opposite extreme, equally absurd, is that no more reserves are ever proved. In this case, peak of production would be with us now and the area inscribed by the curve would be far less than 100 billion barrels. It is probable, of course, that reserves in the future will be found with increasing difficulty—that the last quarter of reserves may not be found for several centuries. The result would be a very long tail on the production curve. But whether reserves are found more rapidly or more slowly than rate of demand affects only the height of the peak and the sharpness of it.

The production curve for the world is shown in Figure 3. An ultimate reserve of 1000 billion barrels has less foundation of geologic data than estimates for the U. S. Most petroleum people feel that political and economic hurdles in foreign countries may retard discovery to such an extent that the peak may not reach as high as seven billion barrels, and may therefore descend less abruptly than shown. (A thousand billion barrels is ten times the present "proved" reserve.) But even if the ultimate reserve of the world turns out to be double that now assumed by geologists, the peak should come by the end of this century.

We now have the four numbers required for determination of adequacy. Simple subtraction of supply from demand gives imports for the U. S. and shortage for the world. Estimated petroleum deficiencies in Table 1 are obtained from curves in Figures 1, 2, and 3. The picture is rather surprising in two respects: (1) it makes little difference whether we assume 100 or 200 billion barrels for ultimate U. S. reserve; (2) world shortage seems to be roughly parallel to U. S. import needs.

TABLE 1
Estimated Petroleum Deficiencies

	BILLIONS OF BARRELS PER ANNUM		
	IMPORTS TO MEET U.S. DEMAND		
	For 100 Bil.	For 200 Bil.	World Shortage
1950	0.2	0.2	0
1960	1.5	1.2	1.8
1970	5.0	4.0	3.8
1980	8.4	7.0	7.2

The actual numbers in the table can have little quantitative significance, but the lessons to be drawn from their trend and magnitude are inescapable. In spite of the vastness of U. S. and world petroleum reserves and the probability of continued production for a century or more, we shall be faced within a few years (not a few decades) with fundamental decisions with regard to liquid fuel supplies. Potential productive capacity in this country is somewhat higher than actual production but at slightly higher cost. This is shown by our increasing imports. If we could not import we could still take care of our needs by domestic production alone but it is better, on both conservational and economic grounds, to import a portion of our requirements. This situation cannot continue more than a few years longer. Imports should soon cost more because of competitive bidding from the rest of the world. And by 1960 it seems that domestic production even up to the limit of productive capacity will not meet domestic needs. At the time when imports become essential they will be expensive, and as the need for im-

• See OIL'S OUTLOOK, page 223

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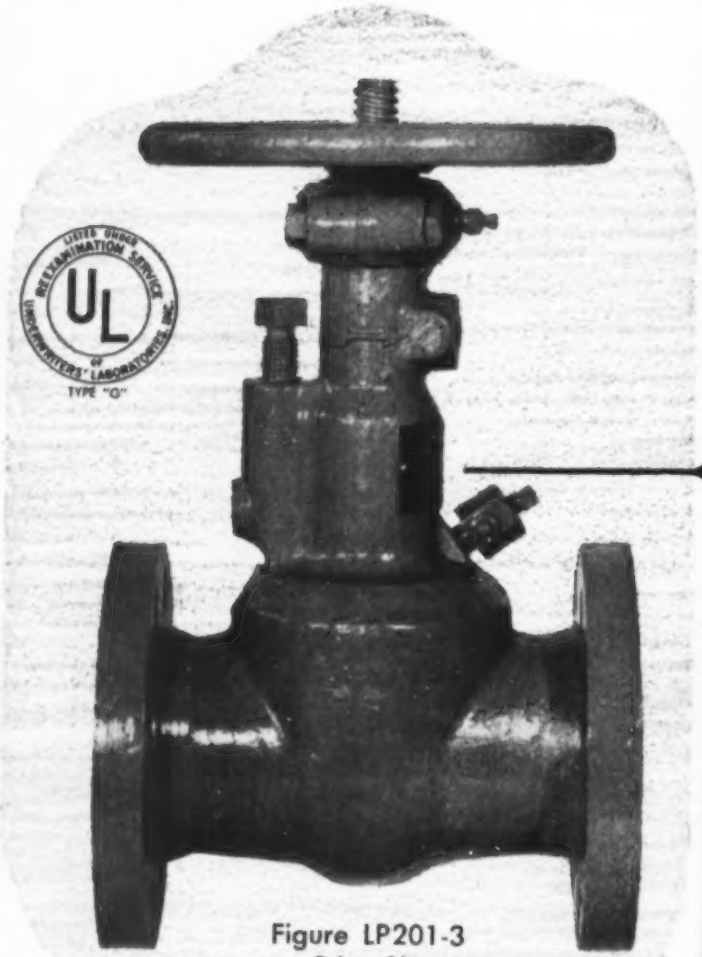

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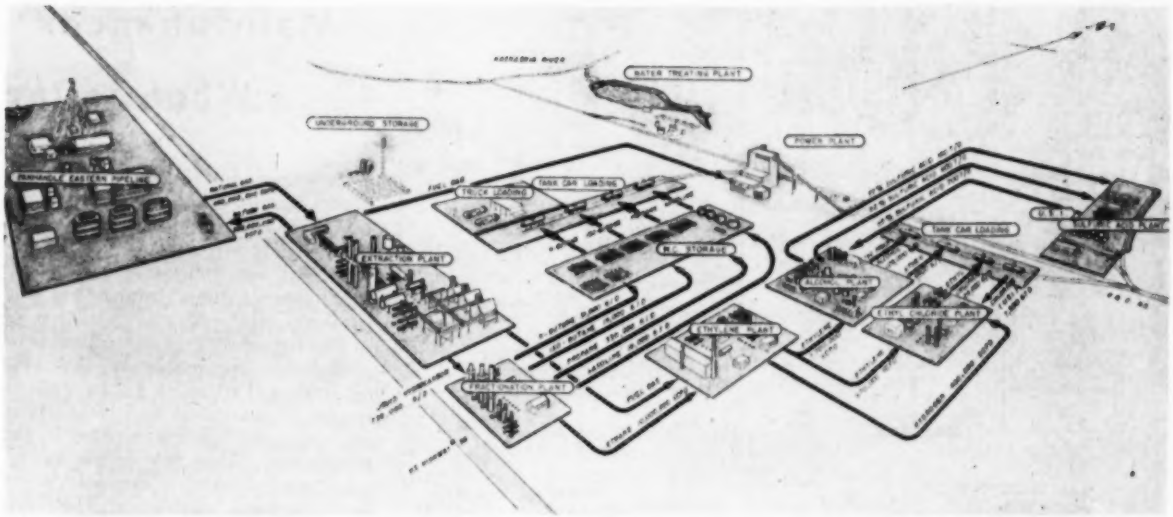


Artist's sketch showing location of the several units in National Petro-Chemicals Corporation's plant at Tuscola, Ill.

Tuscola Plant Termed World's Largest

National Petro-Chemical Corporation installation will have daily output of 450,000 gallons of liquids from natural gas.

National Petro-Chemicals Corporation's $44 million project at Tuscola, Ill., has passed the first step towards completion with the hydrocarbon extraction and fractionation units of the plant now processing natural gas from the Panhandle Eastern Pipe Line Company's line.

These units comprise the largest plant in the world for the recovery of hydrocarbons from natural gas. When operating at full capacity, the plant will process 400 Mmcf, a day of natural gas and will have a daily output of 450,000 gallons of natural gas liquids, i.e., propane, butane, isobutane, and natural gas. In addition, 10 Mmcf, a day of ethane will be recovered from the natural gas for conversion into ethylene, which will be the raw material for chemical units scheduled to go into production in September of this year. The initial chemical production will consist of 40 million gallons a year of synthetic ethyl alcohol and 50 million pounds a year of ethyl chloride. This will be followed by production of polyethylene early in 1955.

Joint Venture

National Petro-Chemical Corporation is a joint venture of National Distillers Products Corporation (60 percent) in partnership with Panhandle Eastern Pipe Line Company (40 percent). Its plant is built on 442 acres of land west of Tuscola, at the junction of two major gas transmission systems.

In addition to the hydrocarbon recovery and processing units and the chemical plants, the Tuscola project includes a complete power plant, and a 25-acre artificial lake.

Waste for the plant will be taken from the reservoir and will pass to the water treating plant for removal of suspended materials, softening and pH correction and, in the case of domestic water, chlorination. The reservoir is fed by the Kaskaskia River, which adjoins the company property.

Four Major Contractors

Four major contractors produced the detailed designs and drawings for construction of the plants.

J. F. Pritchard & Company, Kansas City, carried out the design and construction of the hydrocarbon extraction and fractionation units, the LP-Gas storage tanks, the powerhouse, water treating plants and waste disposal units.

The underground storage cavern for propane storage was constructed by MacLean, Grove & Company, Inc., of New York.

The Lummus Company, New York, did the design and construction of the ethylene unit. The alcohol plant was designed by Vulcan Copper & Supply Company of Cincinnati and built by J. F. Pritchard & Company. Foster Wheeler designed and built the ethyl chloride plant.

Mill Creek Chemical Plans Utah Anhydrous Ammonia Plant

Plans for building an anhydrous ammonia plant in the Salt Lake City area have been announced by Mill Creek Chemical Company, a newly formed independent. The plant is to be built by Tears Engineers and Henry C. Beck Company, Dallas, Texas.

The new facilities are to have a daily capacity of 180 tons of anhydrous ammonia. They will also produce over 30 tons of dry ice daily.

Possible Site for Refinery to Be Bought by Esso Standard

Esso Standard Oil Company will purchase approximately 846 acres in Norfolk County, Va., as a site for an oil refinery should the compnay decide to build a new plant on the East Coast. Options on the site, located on the west side of the Elizabeth River between Craney Island and West Norfolk, have been held by the company for more than

■ CONTINUED ON PAGE 203

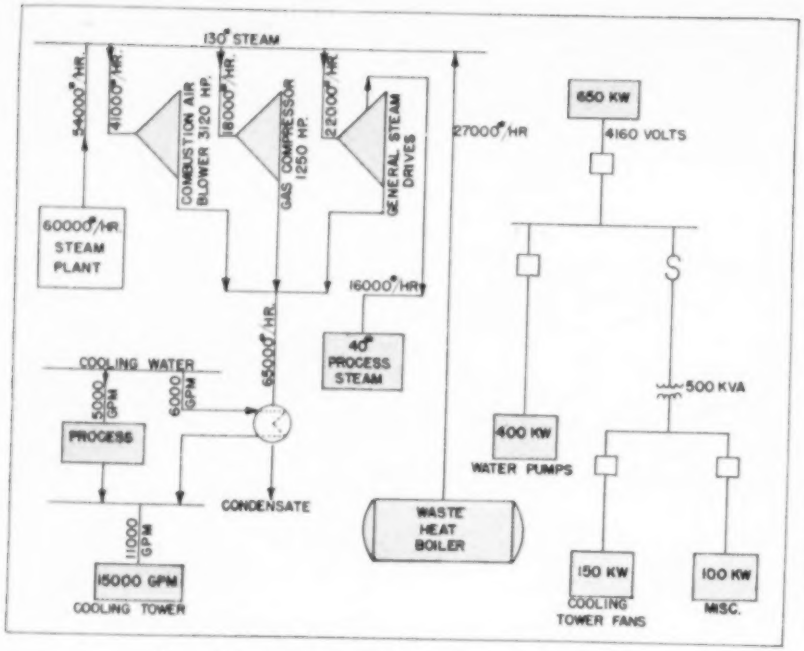


Figure 1. Small fluid catalytic cracker steam turbine drives.

For FCCU, an economic comparison—

Electric Motors vs. Steam Turbines

A new trend is the use of electric motors for drivers on cat units. How do they compare with steam turbines? Here is a factual comparative evaluation based strictly on economics

H. C. Mayo
The M. W. Kellogg Company,
New York

A FLUID CATALYTIC cracking unit requires a large amount of power with a high degree of continuity. The initial investment and operating cost are materially influenced by the drivers employed.

This study will present an analysis of the investment cost, operating cost, flexibility of operation and operating record of steam turbine and electric motor drivers.

In order to give a realistic picture of the cost and economy involved, typical fluid catalytic cracking units have been set up and investment and operating cost for electric and steam turbine drivers in various locations determined.

Originally presented as "Comparison of Electric Motors and Steam Turbines as Drivers for Fluid Catalytic Cracking Units" at the semi-annual meeting of the American Society of Mechanical Engineers, Los Angeles, July, 1953.

Process Description

The fluid catalyst cracking process is one for converting relatively heavy hydrocarbon oils to lighter fractions as required for aviation and high grade motor gasoline. This is accomplished by contacting feed with a continuously regenerated bed of hot powdered catalyst under the proper conditions of time, temperature and pressure.

The regenerator of a medium sized unit holds approximately 100 tons of catalyst. Failure of combustion air results in deaeration and compaction, or "slumping" of the catalyst in the regenerator. When this occurs in certain types of units, it may take hours to reestablish circulation; for this reason, reliable air supply is essential.

Economics

It is understandable that the designers of the first fluid catalytic cracking unit, which went on stream in 1941, chose a steam turbine as the driver for the air blower. However, in today's highly competitive market it behooves all engineers to examine carefully the economics of the various phases of design. Figure 1 shows the utility conditions for a small unit employing condensing steam turbine drivers. Driving power is largely concentrated in the combustion air blower, gas compressor and refrigeration compressor.

The waste heat boiler generates 27,000 pounds of steam per hour, whereas the process requirements are only 16,000 pounds per hour. When using condensing steam turbine drivers on the large machines, a steam flow of 54,000 pounds per hour from the refinery system to the unit is necessary. If no spare steam generating capacity exists, this unfavorable balance necessitates the installation of a 60,000-pounds-per-hour steam generator. The condenser for the three large turbines requires 6000 gpm of cooling water out of a total of 11,000 gpm for the entire unit.

Figure 2 shows the utility diagram for the same unit using electric motor drivers on the air blower and gas compressor. Steam produced in the unit at 130 psig is used in back pressure or condensing extraction drivers to supply the process steam requirements. Steam returned to the refinery is treated as a credit in the economic studies. Use of motor drivers changes the steam requirements from a 54,000-pounds-per-hour deficit to a 5000-

Costs

figures show?

pounds-per-hour surplus. Cooling water is reduced from 11,000 to 5650 gpm and use of electricity is increased from a rate of 650 to 4100 kw.

Economics affecting the selection of motor or turbine drivers center principally around the installed cost of steam generating equipment, cost of fuel used in steam generation, the capital expenditure necessary to bring reliable power to the site, and the cost of electricity, all of which vary widely in different parts of the country. Cost of steam generating equipment used for comparison purposes is based on the costs of outdoor type plants in the Southern States.

The practice of different electric supply companies with regard to providing multiple feeders with automatic switching between feeders varies. Some companies provide a single service at no charge with additional services being provided at the customer's expense. Other companies provide dual feeders at no additional charge. If the existing electric service is not reliable, the service company should be contacted before economic comparisons are made to determine charges for bringing the required feeders to the refinery.

The costs of electricity, gas and fuel oil used in the present comparison are based upon those obtained from a number of Cities as shown in Table 4. Cost figures used do not include cost of steam or electric lines outside the unit limits.

Consideration must be given to the fact that off grade fuels are sometimes available in a refinery at less than listed marked values for commercial grade fuels. However, any fuel burned must be assigned a price equal to the return that could be realized by its sale. Many refineries burn large quantities of natural gas to supplement refinery waste fuel.

Cost of Steam Versus Electric Drive

This section presents a brief comparison of steam drive vs. electric drive for three cases, A, B, and C.

Case A—Small Unit—Condensing Turbine

Cost estimates are based on unit for which utility balances of Figures 1 and 2 were obtained. See Table A.

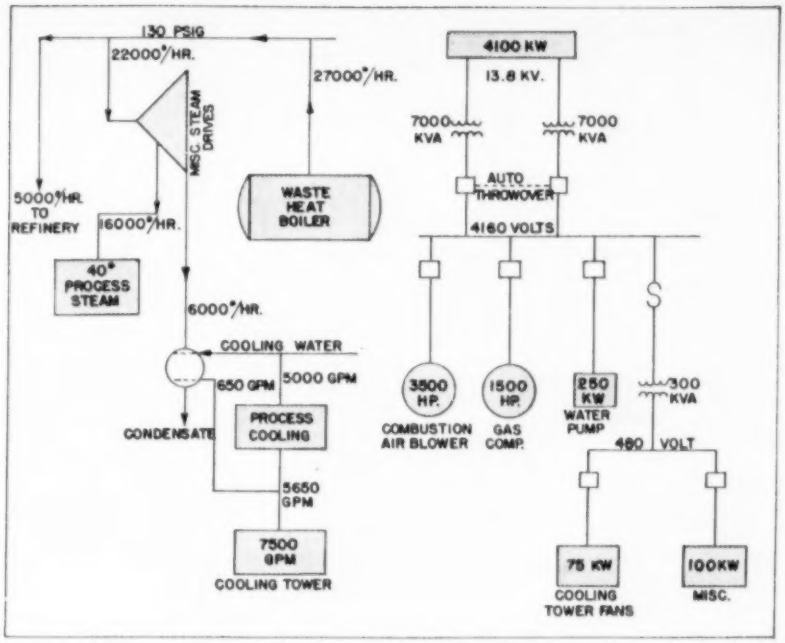


Figure 2. Small fluid catalytic cracker electric motor drives.

TABLE A

	Turbine Drive	Motor Drive
Steam Generator, 90,000 lbs. hr.	$400,000.	
Compressors, Condensers, Drivers	185,000.	$176,000.
Cooling Tower and Accessories	200,000.	110,000.
Piping	15,000.	
Electrical System and Starters	29,000.	151,000.
	$829,000.	$437,000.
Investment Savings on Electric Drive	$392,000.	

Table 1 shows the equivalent costs of fuel and electricity for write-offs of from 3 to 6 years. Cross reference to Table 4, "Fuel and Electricity Costs in Different Areas," will indicate areas in which electric motor and steam turbine drives can be economically applied.

Case B—Small Unit—Back Pressure Operation

Figure 3 shows the Utility Diagram for a unit of similar size driven by 600 psig—750° FTT steam with topping turbines exhausting to a 130 psig system. This system requires 110,000 pounds per hour of 600 psig—750° FTT steam and results in a net of 115,000 pounds per hour to the 130 psig refinery system.

The comparison of the estimated cost of the steam system and turbine

TABLE B

	Turbine Drive	Motor Drive
Steam Generator, 125,000 lbs. Hr.	$725,000	
Compressors, Drivers	165,000	$176,000
Cooling Tower and Accessories	110,000	110,000
Piping	10,000	
Electrical System and Starters	29,000	151,000
	$1,039,000	$437,000
Investment Savings on Electric Drive	602,000	
Credit for 125,000 lbs. Hr. Steam Generator	675,000	
Additional cost of Electrical System if credit is taken for Cost of 150 psig steam generation	$ 73,000	

TABLE 1
Equivalent Cost of Fuel and Electricity
Condensing Steam Turbines Versus Electric Motor Drives
For Small FCC
(130-lb. Steam, Reference Figures 1 and 2)

FUEL COST		COST OF STEAM BEFORE AMORTIZATION CENTS PER 1000 LBS.	COST OF ELECTRICITY TO WRITE OFF ADDITONAL INVESTMENT FOR STEAM SYSTEM (Cents Per Kwh)			
			WRITE OFF TIME IN YEARS			
Gas—Cents Per Million Btu	Fuel Oil Per Barrel	150 Lbs.	3	4	5	6
5	$0.30	14	0.781	0.647	0.565	0.51
10	0.60	22	0.920	0.784	0.700	0.646
15	0.90	29	1.04	0.902	0.820	0.766
20	1.20	37	1.17	1.04	0.956	0.903
25	1.50	45	1.31	1.17	1.09	1.04
30	1.80	52	1.43	1.29	1.21	1.16

7000 hours operation.

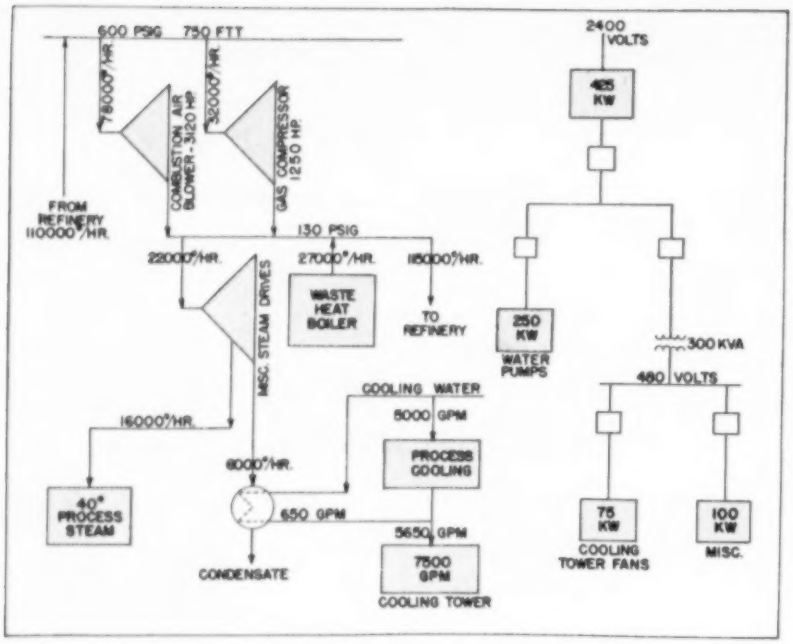


Figure 3. Small fluid catalytic cracker back pressure turbine drive.

installation (Figure 4) and the electrical system and motor drives (Figure 3), for this case is presented in Table B.

If the 130-pound steam is needed and construction of steam generating capacity is necessary, credit can be taken for the cost of the low pressure steam generator and the resulting installed cost is less than the cost of the electrical system. The annual operating cost of the back pressure steam turbine drives, without amortization of the steam system, is only a fraction of the annual operating cost of electric motor drivers. However, if the existing 130-psig steam generating equipment is adequate but it is decided to discontinue its use and supply the 130-psig requirements from the high pressure turbine exhaust, then the difference in investment is approximately $602,000. If standby steam generating capacity is required, the differential cost will be increased accordingly.

Table 2 shows the equivalent costs of fuel and electricity for write-offs of from 3 to 6 years. Cross reference to Table 4, "Fuel and Electricity Cost in Different Areas," will indicate areas in which the different systems can be economically applied.

Case C—Large Unit—Condensing Turbine

Figures Nos. 4 and 5 show the Utility Flow Diagrams for a large Fluid Catalytic Cracker employing condensing steam turbine drivers and electric motor drivers, respectively. Table C shows the estimated investment cost of the two.

TABLE C

	Turbine Drive	Motor Drive
Steam Generator, 180,000 lbs. Hr.	$ 925,000	
Compressors, Condensers, Drivers	805,000	$873,000
Cooling Tower and Accessories	654,000	442,000
Piping	95,000	
Electrical System and Starters for Compressors	63,000	206,000
	$2,542,000	$1,521,000
Investment Savings on Electric Drive: $1,021,000.		

The additional investment cost of the steam system is approximately $1,021,000.

The greater economy in the use of high pressure high temperature steam is indicated in Table 3. Cross reference to Table 4 shows that there are many areas where the lower operating cost of the steam system and steam drivers will result in an indicated payoff of less than three years. The tables also indicate that there are areas where the write-off will exceed five years.

Suitability of A.C. Electric Motors As Drivers for Centrifugal Compressors

The high permissible operating speed and variable speed operation make the steam turbine an ideal driver for a centrifugal compressor. Capacity and discharge pressure are easily and economically controlled by speed

TABLE 2

Equivalent Cost of Fuel and Electricity
Back Pressure Steam Turbines vs. Electric Motor Drives
For Small FCC

(600-lb. Steam, Reference Figures 2 and 3)

FUEL COST		COST OF STEAM BEFORE AMORTIZATION CENTS PER 1000 LBS.		COST OF ELECTRICITY TO WRITE OFF ADDITIONAL INVESTMENT FOR STEAM SYSTEM (Cents Per Kwh)			
				WRITE OFF TIME IN YEARS			
Gas—Cents Per Million Btu	Fuel Oil Per Barrel	150 Lbs.	600 Lbs.	3	4	5	6
5	$0.30	14	15	0.815	0.616	0.498	.....
10	0.60	22	24	0.838	0.659	0.522	.....
15	0.90	29	32	0.871	0.673	0.556	.....
20	1.20	37	41	0.903	0.705	0.587	0.511
25	1.50	45	50	0.930	0.732	0.615	0.537
30	1.80	52	58	0.960	0.763	0.645	0.568

7000 hours operation.

TABLE 3

Equivalent Cost of Fuel and Electricity
600 Psig—750° F.T.T.—Condensing Steam Turbines Versus Electric Motor Drives for Large FCC

(600-lb. Steam, Reference Figures 3 and 4)

FUEL COST		COST OF STEAM BEFORE AMORTIZATION CENTS PER 1000 LBS.		COST OF ELECTRICITY TO WRITE OFF ADDITIONAL INVESTMENT FOR STEAM SYSTEM (Cents Per Kwh)			
				WRITE OFF TIME IN YEARS			
Gas—Cents Per Million Btu	Fuel Oil Per Barrel	150 Lbs.	600 Lbs.	3	4	5	6
5	$0.30	14	15	0.453	.....	.....	.....
10	0.60	22	24	0.543	0.467	.....	.....
15	0.90	29	32	0.622	0.547	0.501	.....
20	1.20	37	41	0.712	0.635	0.590	0.560
25	1.50	45	50	0.802	0.726	0.680	0.650
30	1.80	52	58	0.883	0.806	0.761	0.731

7000 hours operation.

variation. Motor top speeds on 60-cycle systems are limited to 3600 rpm. In most cases, motor driven centrifugal compressors use geared slow speed motors. Speed control is possible, but expensive.

The operating range of commercially available constant speed centrifugal compressors is adequate for any application in a Fluid Catalytic cracking unit. However, the power input at reduced capacity and rated discharge pressure is slightly greater on constant speed centrifugal compressors than on variable speed compressors operating at reduced speed, and is substantially higher on fixed speed compressors operating with rated inlet conditions and reduced discharge pressure, or rated discharge pressure with higher than rated inlet density.

Safety and Reliability of Electric Drive

Either forced air ventilated synchronous or induction motors with air taken from an elevated intake stack provide installations suitable for refinery service. Large numbers of such machines have been in successful operation on other refinery drives, such as slow speed reciprocating compressors, for years.

The dependability of the electric motor is attested to by its use in preference to steam turbines as the accepted driver for boiler feed pumps and forced and induced draft fans in central station electric generating stations. Control equipment for induction motors is simpler than for synchronous motors. In addition, induction motors develop higher torques and are less affected by voltage surges or short power interruptions. Use of electric drives in the past has been limited by fear of a power failure. This unknown more than other factors has influenced the engineer's decision and resulted in an overwhelming majority of steam turbine installations. Normally, the steam generating plant contains a number of units, failure of any one of which would not cause loss of the steam supply.

There are many electrical systems whose continuity record is poor. Any electrical system employing a single transmission line of appreciable length is a poor continuity gamble. Inherently, there will be power failures due to equipment failure. Use of a motor driven main air blower supplied from such an electrical system would be a mistake, regardless of any possible initial capital savings. On the other hand, there are many electrical systems with a proven continuity record. Records of an electrical service company in New York City show that many customers have never experienced a power failure and that on an average, only one customer out of each 180 will have a power failure in any one year. The average duration of power failures is 175 minutes.

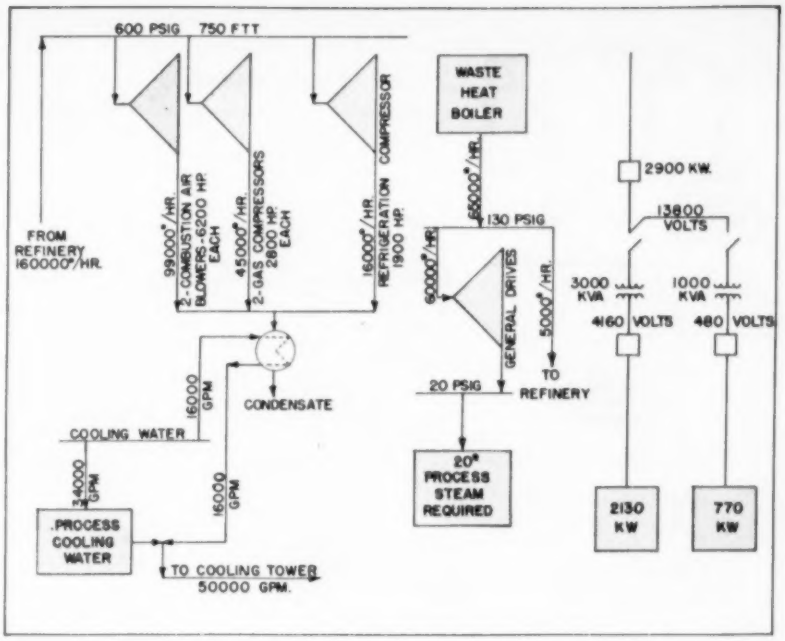


Figure 4. Large fluid catalytic cracker steam turbine drives.

An electric service company in Colorado checked records of the past five years on the power failure experience of the two largest refineries in the Denver area and found the following:

(a) One power failure occurred with a duration of one minute. Since an alternate feeder was available to the customer, his automatic throwover switch restored service almost instantly.

(b) Six power failures of less than two seconds duration occurred. These were all momentary interruptions and in all cases, the circuit breaker reclosed immediately.

(c) No other power failures occurred.

TABLE 4

Cost of Electricity, Gas and Fuel Oil in Different Cities

LOCATION	Gas Cents Per Million Btu	No. 6 Fuel Oil Dollars Per Barrel & Million Btu	Electricity Cents Per Kwh
Boston, Mass.			1.02
Denver, Colo.	14.5		0.70
Detroit	40.	3.00	1.01
East Chicago, Ind.	43.3	3.42	1.065
Houston	8.00	1.00	0.52
Little Rock, Ark.	13.58	1.74	0.70
Los Angeles	22.1	2.00	0.524
Minneapolis		2.31	1.25
Montreal, Canada		2.73	0.605
Newark, N. J.		2.55	0.835
New Orleans	13.00		0.75
New York City	27.4	2.10	1.3
Philadelphia	29.1	2.03	0.85
Pittsburgh	39.9		0.9
Redwood City, Cal.	29.8	1.90	0.841
San Francisco,	29.8	1.90	0.841
Toronto, Canada			0.5
Tulsa	13.	0.90	0.74
Tuscon, Arizona	27.		1.1
Wichita, Kansas	16.5	1.10	0.686
Winnipeg, Canada	*	2.38	0.434

Electricity cost based on 5000 kw, High P.F., 7000 hours annual use.
* Not available.

Horsfall, Thompson, Mills and Bobo, in AIEE Paper 50-261, (AIEE Transactions Volume 69, 1950), described the electrical controls used on the electrical system at the Lima refinery of The Standard Oil Company (Ohio) where a large fluid catalytic cracking unit using motor driven air blowers is located. Described is an electrical system that has produced continuous electric service for years.

Distances between major generating stations in most industrial areas are short. An electrical distribution system of moderate length supplied by two or more generating stations and dual transmission facilities with automatic switching between transmission lines will provide a high degree of continuity. A large proportion of power failures on such systems will last for the time required to switch from one feeder to the other, less than two seconds. Simultaneous equipment failure on both systems is unlikely, but if it does occur, would on

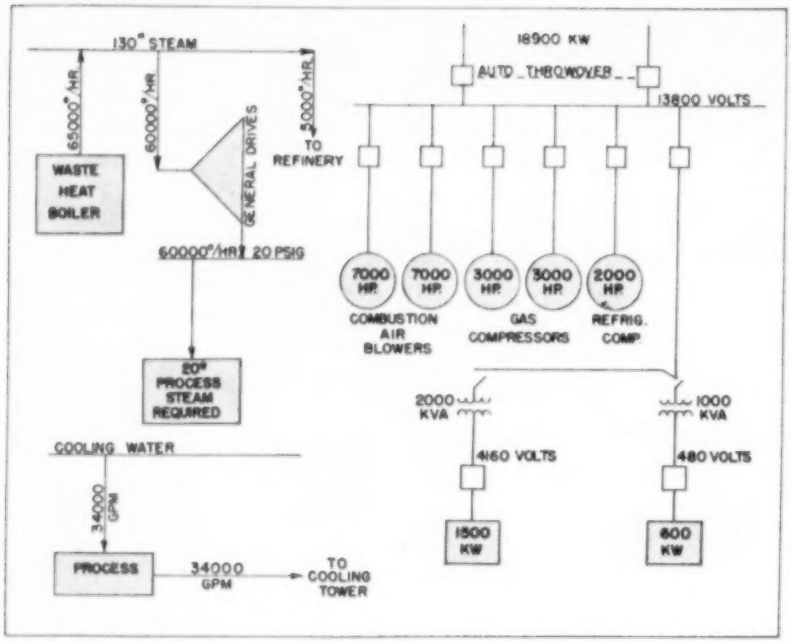


Figure 5. Large fluid catalytic cracker electric motor drives.

an average, result in long outage times comparable to that experienced in New York City (average 175 minutes).

Experience with units now in operation shows that power failures of a few seconds have little effect and power failures up to ten seconds can be tolerated. Experience with refineries in general indicates that long power failures usually interfere with the cooling water supply and make operation of any unit involving distillation equipment difficult or impossible.

Operating Record

In the summer of 1951, a FCCU employing a synchronous motor driven main air blower was put on stream by a large refiner. The refinery's utility engineer writes in part as follows:

"I do not have any formal records of cat cracker shutdowns due to electric power failure, mainly because there have been none. There have been several short-time interruptions which the refinery, as a whole, rode through quite satisfactorily. As far as the Catalytic Unit is concerned, it seems to give less trouble than the Atmospheric and Vacuum Unit. We are quite convinced that an electric motor is a satisfactory driver for an air blower and a centrifugal compressor providing power is available at the refinery site without too great a capital expenditure, and providing the power system has the capability to start the equipment, and providing the power system has a good continuity record."

This refinery has under construction, a FCCU in a different location which will use induction motor drivers on the main air blower and on the gas compressor.

In 1948, a large refiner in the north Central States put a FCCU on stream using two 3000-hp synchronous motor driven main air blowers. Initially, some trouble was experienced with the controls on the two synchronous motor driven machines. There have been no shutdowns of this unit due to failure of power, motor control equipment, or motors, to date. There have been a number of short time interruptions which caused no difficulty. If steam turbine drivers had been used, it would have been necessary to employ a stationary engineer to operate the turbines but no such requirement has been necessary for the motor drivers. The motors have required virtually no maintenance. The operating cost of the motor drivers has been less than the calculated operating cost of the turbine drives, plus the cost of the stationary engineers.

TABLE 5

Partial List of FCC Using Electric Motor Driven Main Air Blowers

COMPANY	Location
Atlantic Refining Co.	Philadelphia
Atlantic Refining Co.	Philadelphia*
Bay Petroleum Co.	Denver, Colo.*
Ben Franklin Petroleum Co.	Ardmore, Okla.*
British American Oil Co., Ltd.	Toronto, Ontario*
Eldorado Refinery Co.	Eldorado, Kan.
Globe Refining Co.	Lamont, Ill.
Imperial Oil Ltd.	Winnipeg, Man.
Imperial Oil Ltd., IOCO Refinery	IOCO, British Columbia*
Kanotex Refining Co.	Arkansas City, Kan.
Northwestern Refining Co.	St. Paul Park, Minn.*
Rock Island Refinery	Indianapolis
Standard Oil Company (Ohio)	Lima, Ohio
Standard Vacuum Refining Co., (PTY)	Durban, Africa*

* Under construction.

A FCCU is being built for a Canadian refiner. Electric power is available at a cost of 0.5 cents per kwh. No spare capacity exists in the refinery steam system. Economic studies show a savings in initial investment of $500,000, if a motor driven air blower is used. The refiner decided to use an electric motor driven main air blower.

An East Coast refiner installed a FCCU with an electric motor driven main air blower during World War II, and is, at present, building a large unit using synchronous motor drivers on the air blower, gas compressor and refrigeration compressor. In this case, the refiner is only a few miles from an electric generating station. The refinery will be supplied with electric power over three separate underground cables operating in parallel. Two cables have the capacity to carry the entire load. In case of cable failure, the faulty cable will be automatically disconnected and the refinery continue to operate.

Conclusions

Plant investment costs can be substantially reduced by the use of electric motor drivers in cases where the steam system is inadequate and where reliable power is available without too great a capital expenditure.

The operating cost for low pressure condensing steam turbine installations is higher in most areas than for electric motors supplied by purchased power.

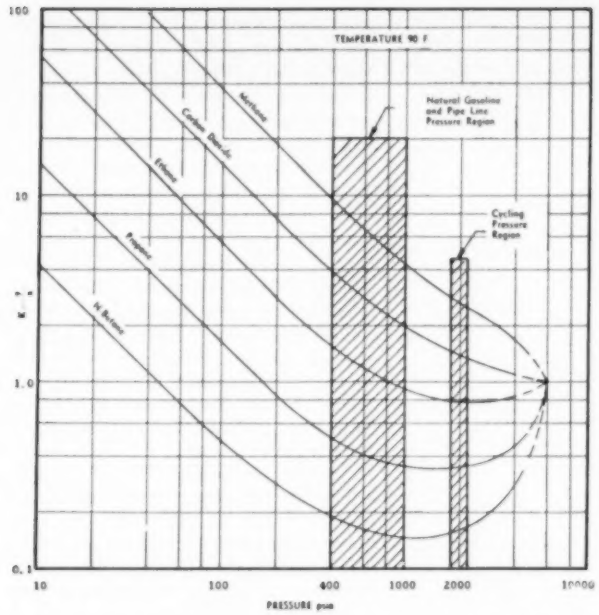
The operating cost for high pressure, high temperature steam turbine installations is lower in many areas than for electric motors. However, in areas where cheap hydro-electric power is available, the operating cost of motor drivers may be lower.

The maintenance costs of electric motors and the electrical system are lower than for turbines, condensers and cooling towers.

Cooling water requirements are reduced from 30 to 50 percent and space for cooling towers and steam generators is greatly reduced by the use of motor driven compressors.

Well designed electrical systems will provide the required service continuity.

Commercially available constant speed centrifugal compressors have sufficient operating range for any application in a fluid catalytic cracking unit.



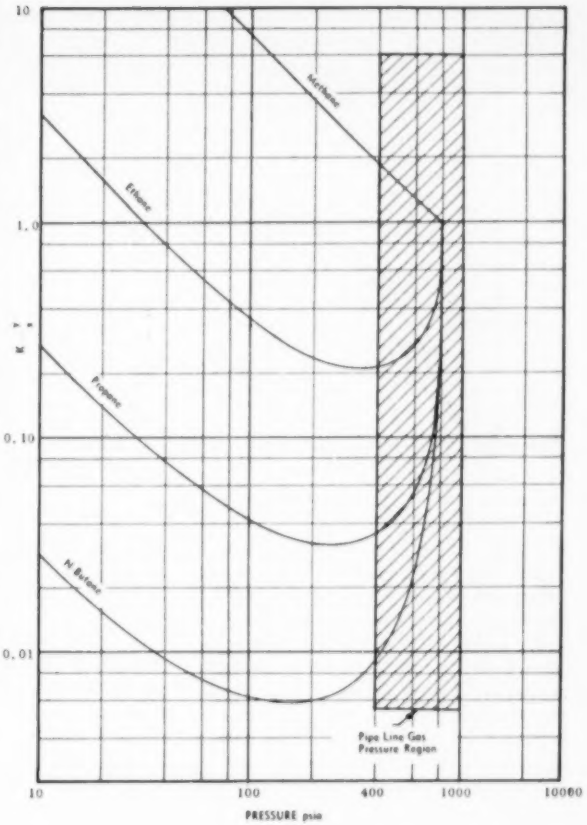


Figure 1 (above). Equilibrium constants for natural gas—Absorption oil systems at 90 F. Figure 2 (above, right). Equilibrium constants for natural gas—asborption oil systems at —100 F. (Note that the operating pressure region is in the converging or critical pressure region).

Do You Have Enough . . .

Thermodynamic Data for Low Temperature Design?

At low temperatures—

- **Accurate data may result in lower refrigeration costs**
- **Operating pressures are high relative to convergence pressures**
- **Equilibrium data are very sensitive to composition and pressures**

Donald L. Katz, Ralph H. Schatz and Brymer Williams
Department of Chemical Engineering, University of Michigan, Ann Arbor.

THE EFFICIENT RECOVERY of greater amounts of propane and ethane from natural gas is the backbone of the petrochemical and natural gasoline industries. Designs for this deep extraction create areas where there is a dearth of thermodynamic data even though there has been produced large volumes of significant information for the usual design problem.

This paper presents a brief review of data available on vapor-liquid equilibria, densities, viscosities, and thermal properties. The deficiencies in the data significant in deep extraction will be noted. In general, thermodynamic properties are most unpredictable at pressures approaching the vapor-liquid critical pressure and data are insufficient in the low temperature region, i.e., —50 to —150 F.

The pressure of a given operation is probably the most significant variable in determining the nature of an extraction process. The composition of the natural gas from which the liquefiable hydrocarbons are being removed is also important.

Phase Equilibria

Many measurements of equilibrium vapor and liquid compositions have been reported since ideal equilibrium constants ($K = y/x$) were computed from fugacities,[7,40] and there have been numerous correlations of data. A complete bibliography of phase equilibria would fill a book;[18] however, a group of selected references are segregated by subject in Table 1. For many

TABLE 1
Selected References for Vapor-Liquid Equilibria

Types of Research	Reference Numbers
Crude Oil—Natural Gas Systems	17, 30, 32, 33, 42
Absorber Oil—Natural Gas	22, 35, 37, 38, 39, 45
Condensate—Natural Gas	15, 20, 31, 34, 3.
Binary Systems	13, 19, 37, 38
Low Temperature Data	11, 12, 13, 43, 48
Effect of Non-Hydrocarbon Constituents	1, 12, 30, 31, 38
Correlations of Data	7, 11, 12a, 14, 16, 20, 26, 40, 47

Originally presented as "Thermodynamic Data Required for Deep Extraction," at Houston Meeting of NGAA, April 30.

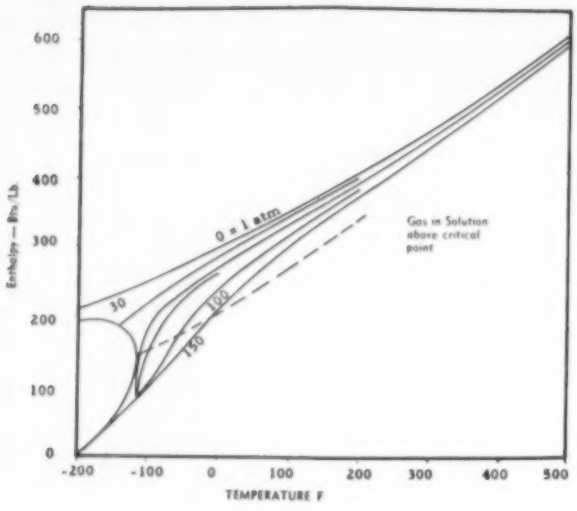


Figure 3. Enthalpy of methane. (Maxwell[23]).

problems cross plots of experimental equilibrium data provide satisfactory information for process calculations. In others, correlations of data may be very useful. The most difficult problems today are those in which the mixtures are at high pressures relative to the maximum two-phase or critical pressure for the mixture. The nature of hydrocarbon systems encountered in extraction and the method of treating problems of this kind will be discussed.

THE APPARENT CONVERGENCE PRESSURE is an important correlating variable. The method of plotting vaporization equilibrium constants which has proven most useful when comparing systems at high pressure is the isothermal log K versus log pressure chart, as in Figures 1 and 2. At low pressures, the ideal equilibrium constants may be used. They nearly follow Raoult's law as lines of slope minus one through the point of vapor pressure at $K = 1.0$.[16] At some high pressure the K appears to approach unity at a critical or apparent convergence pressure.

Correlations based on the convergence pressure concept make a major correction from the usual ideal equilibrium constants and account for the rapid rise toward unity at some high pressure. There are methods for predicting the apparent convergence pressure for complex mixtures but no completely reliable procedure has been evolved for all mixtures.

The various cases for deep extraction will be discussed to show the application of these concepts.

CYCLING PLANTS normally require recovery processes to take place at pressures of 1800-2200 psi since pressure reduction would require extra compression of the gas returned to the reservoir. The hydrocarbon system under consideration in this case is that of absorption oil, methane, and the constituents to be extracted. Figure 1 shows the position of the pressure range for cycling plants on the isothermal equilibrium constant plot. The nature of the absorption oil can become important,[22] large amounts of non-hydrocarbon constituents cannot be neglected, but the degree of extraction of intermediate constituents has little influence on the equilibria as a natural gas consisting only of methane is approached.

PIPE LINE SEPARATIONS or the extraction of ethane and propane from natural gas in transit to the utility market presents somewhat different problems. The pressure normally is below 1000 psi, the maximum pipe line pressure, and is above the suction pressure for a line compressor station.

If a pipe line extraction plant were to use an oil absorption process at temperatures above 0 F., the usual equilibrium data would apply. For low temperature plants such as is used at Greensburg, Ky.,[21] the equilibrium data are likely to be in the pressure region in which the behavior cannot be predicted with accuracy. Figure 2 illustrates the type of equilibrium constants which might be expected for a typical pipe line gas under flash vaporization. Should direct distillation of the gas be considered, the operating temperature for complete removal of ethane would be around —120 F. for a pressure of 630 psi. At this pressure, the equilibrium constants for calculations at the top of the tower would come from the methane-ethane system.**

> "The need for accurate data increases steadily as the processing **temperature decreases.** At subatmospheric temperatures the **design** of a system involves refrigeration equipment as well as heat exchangers. For example, if cooling water is used in a condenser, then the factor of safety or of ignorance is applied primarily to the amount of exchanger surface."

TABLE 2
Effect of Hydrogen on Equilibrium Constants at 600 Psia and —100 F.

	Propane	Ethane
C_1-C_2-C_3 System, Figure 2	0.056	0.27
Hydrogen Binary	0.009	0.050

NATURAL GASOLINE PLANTS processing natural gas from crude oil separators may have a rich gas stream to process. However, as extraction by absorption becomes "deep," the phase behavior is dictated primarily by methane and the absorbent. Thus, for such plants, the equilibrium constants are not sensitive to the degree of absorption since the pressures are far removed from any convergence pressure.

For processing with deep extraction by refrigeration, the system at the significant separation point again is primarily methane and ethane.

THE EFFECT OF THE PRESENCE OF NON-HYDROCARBONS such as N_2 or H_2 on the equilibrium constants is that these constituents raise the convergence pressure markedly and thereby lower the volatility of ethane and propane. Table 2 shows the ethane and propane equilibrium constants in the binary systems with hydrogen to be about 20 percent of that in the hydrocarbon system of Figure 2 for a condition of 600 psi and —100 F. It follows that even moderate concentrations of non-hydrocarbons cannot be neglected at these pressures.

SOLIDIFICATION OF CARBON DIOXIDE may also be a problem. At low temperatures, carbon dioxide-hydrocarbon systems precipitate solid CO_2.[14] At temperatures down to —120 F. or lower, no solidification will occur for the CH_4 — CO_2 system with mixtures having less than 5 mole percent CO_2 at pressures below 500 psi.

Thermal Properties

Thermal properties are required to obtain heat balances in process design. The effects of temperature on the enthalpy of gaseous and liquid streams are readily obtained[23,29] and the effects of pressure on the enthalpy

**Institute of Gas Technology has determined methane-ethane system.

of natural gases were determined by calculation.[9] The real problems lie in heats of vaporization or solution[38] for mixtures. These properties are most difficult to determine at pressures approaching the apparent convergence pressure, the operating region of low-temperature plants. Although the latent heat of vaporization becomes zero at the critical temperature, for a pure constituent, there is a heat of vaporization or condensation for the constituent above its critical point as it dissolves or evolves from a solution.

ENTHALPY CHARTS may be used where heat balances for mixtures are made under conditions in which the behavior may be considered ideal. The summation of individual enthalpies taken from pure charts does not lead to any serious error.[23] However, the charts are not generally applicable as in the high-pressure absorbers in cycling plants. For example, at 2000 psi and 90 F., methane is in the liquid state at conditions above its critical point. The heavier components like butane or propane are in the vapor phase in the cycling plant while as pure components they would be subcooled liquids. Obviously, if heats of solution to and from mixtures are different from latent heats of the pure compounds, the temperature-enthalpy diagrams are not directly usable. Sometimes heat balances are made or heats of solution are determined by extrapolating the vapor lines into the pure liquid region as shown on Figure 4 for the 400 and 600 psi lines.[35] Figure 3 shows a curve for methane when dissolved at temperatures greater than its critical. Another version of these charts has been proposed by Peters[29] in Figure 4, in which the enthalpy of a component in solution above its critical temperature is given as a function of the molecular weight or molal average boiling point of the liquid phase. This is a means of recognizing the effect of composition on the critical or on the convergence pressure.

Another method by which heat balances for mixtures can be computed is based upon the charts furnished by Brown and Holcomb,[7,8] which give the enthalpies and specific heats of hydrocarbons in the liquid and in the vapor state at zero pressure. The enthalpies of the constituents for any liquid or vapor phase can be summed to give the enthalpy of a mixture at zero pressure. The effect of pressure upon the enthalpy of a mixture is then estimated from a chart which gives the enthalpy correction as a function of the pseudo reduced conditions. For pure compounds, this method gives the same type of results as the use of Maxwell's

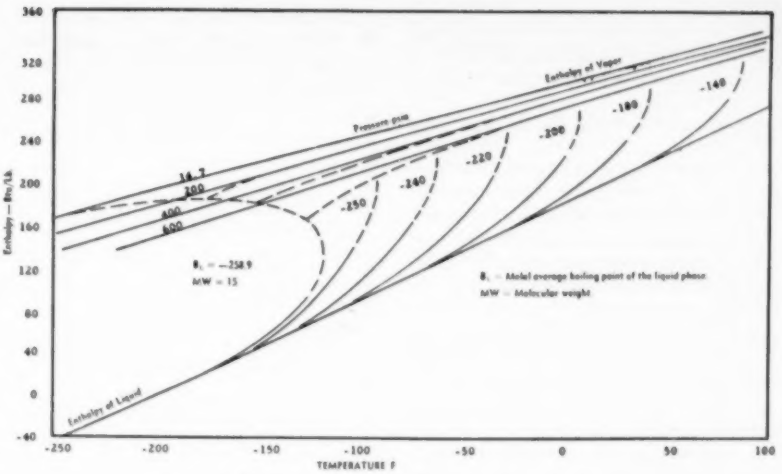


Figure 4. Enthalpy of methane in Hydrocarbon mixtures.

charts.[23] This correction for effect of pressure on mixtures is valid only for mixtures which obey the theorem of corresponding states and consequently will give results which are, at best, doubtful for mixtures with non-hydrocarbons, such as nitrogen and carbon dioxide.

AS A COMPARISON of these various means of evaluating heats of condensations, Table 3 gives the computed heat removal in a reflux condenser on a demethanizer following an ethane pyrolysis unit. Tower top conditions are 500 psia and —135 F. and the overhead gas contains over 60 percent hydrogen. The differences are not too large by ordinary standards, but at such low temperatures refrigeration is costly and it may often be desirable to predict duties with more assurance.

Each of these methods in Table 3 requires either the assumption of ideal gas or of ideal solution behavior. None of these methods considers the effect of composition upon the enthalpy of a component in a mixture and there are many instances in practice where this effect must be serious. In general, if it is necessary to consider the effect of composition (or critical pressure) on the equilibrium constant K, it should also be necessary to consider the effect upon enthalpies or heats of solution. Dr. Otto Miller[24] was one of the first to demonstrate this by measuring experimentally the heat of solution of normal butane in a 145 M. W. paraffinic solvent as a function of butane concentration for temperatures from 150 to 350 F. and from 100 to 600 psi. For example, the heat of solution of butane at 300 F. and 400 psia increased from by 30 percent as the concentration of butane in the liquid increased from 10 to 25 mole percent.

The API Research Project No. 37 directed by Professors B. H. Sage and W. N. Lacey is essentially the only source of partial heats of solution which are based upon experimental measurements. They have reported that the heat of absorption of methane in pentane is not large but varies considerably. Similarly, the heat of vaporization of pentane into gaseous methane is large, but the quantity of pentane so involved is small. These saving facts are familiar to all designers of high pressure absorbers. However, although the practical consequences may be rather unimportant in such a case, the data do illustrate the fact that the heat of absorption is drastically affected by the composition.

Unfortunately, these thermodynamic data do not yet cover too many systems of interest in deep extraction, and a satisfactory correlation is not at hand which will be suitable for all specific mixtures.

"At a temperature below that of available cooling water the factor of safety must be applied to the refrigeration equipment as well as to the exchangers. **Refrigeration is costly.** To reach —150 F. by a cascade system of evaporative cooling with ethylene and propane requires about 700 brake horsepower per 1 million Btu, a quantity **seven times greater** than necessary to furnish cooling at 30 F."

TABLE 3
Comparisons of Heat Balances by Different Methods

Method of Computation	Duty
1. Enthalpy—Temperature Plot—Maxwell	5,000,000Btu/hr
2. Enthalpy of mixture at zero pressure corrected for pressure effect	5,300,000Btu/hr
3. Enthalpies of individual components evaluated at zero pressure, corrected for effect of pressure and then summed	5,650,000Btu/hr

"**Enthalpy data** are most uncertain at **low temperatures** where mixtures are in the critical pressure region."

PREDICTIONS OF PARTIAL ENTHALPIES are possible with fair accuracy. There is some hope of obtaining usable enthalpy data before good experimental data become available over a wider range of temperature and pressure. Canjar and Edmister[10] and more recently Papadopoulos, Pigford and Friend[27] have utilized the Kellogg equation of state to compute partial enthalpies for the light hydrocarbons. Where experimental data are available for comparison, the calculated results appear valid. The procedure will yield enthalpies as functions of pressure, temperature and composition. However, the computations are long and complicated and it is interesting to note that the two sets of authors have obtained different numerical values by using different calculation methods based on the same equation of state. Table 4 shows the heat of vaporization calculated by the latter authors for ethane compared with the pure component. The Peters' correlation gives approximately a constant value which is independent of the composition in this range.

"The need for accurate data increases steadily as the processing temperature decreases. At sub-atmospheric temperatures the design of a system involves refrigeration equipment as well as heat exchangers. For example, if cooling water is used in a condenser then the factor of safety or of ignorance is applied primarily to the amount of exchanger surface. At a temperature below that of available cooling water the factor of safety must be applied to the refrigeration equipment as well as to the exchangers. Refrigeration is costly. To reach —150 F. by a cascade system of evaporative cooling with ethylene and propane requires about 700 brake horsepower per 1 million Btu, a quantity seven times greater than necessary to furnish cooling at 30 F."

DENSITY, VISCOSITY AND SURFACE TENSION. Whenever the composition, temperature and pressure are known, the density of a gaseous and liquid hydrocarbon systems may be calculated satisfactorily for the usual design problem.[41,49] The viscosity of gaseous streams may be estimated from the molecular weight.[6,12a] The viscosity of light hydrocarbon liquids may be estimated from pseudo-critical temperature and pressure along with molecular weight.[5]

The surface tension of volatile hydrocarbon mixtures may become very low as the single phase pressure is reached. Data on the methane-propane system have shown that surface tensions may be computed for these conditions.[46]

TABLE 4

Heat of Vaporization of Ethane at 500 Psia Into Vapor of —200 F. Molal Average Boiling Point (MABP)

Temp.	MABP of Liquid	HEAT OF VAPORIZATION OF ETHANE BTU/LB. From Mixture: Equation of State	From Mixture: Peters' Corr.	Pure Component At Temperature
50 F.	0	115	141	113
	180	85		
0 F.	—60	115	142	154
	0	105		
	180	85		
—50 F.	—60	130	143	189
	60	115		

"The presence of hydrogen, nitrogen and carbon dioxide introduce inaccuracies into all correlation methods at **low temperatures.** There are practically no data on these constituents in hydrocarbon mixtures at sub-zero temperatures."

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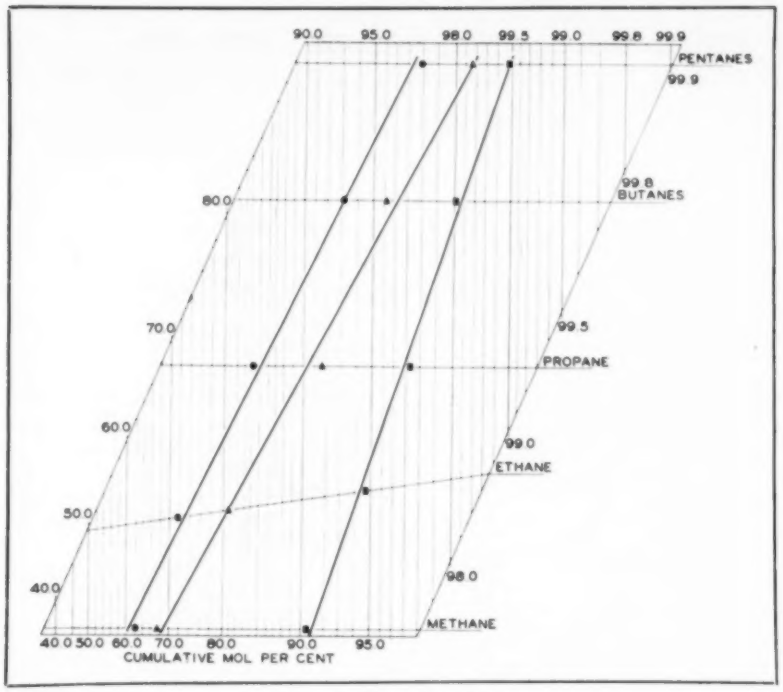


Figure 1. Natural gas chart.

From absorption index and specific gravity - -

Approximating Natural Gas Composition

A chart has been developed which predicts the hydrocarbon composition of natural gas to an accuracy of ± 10 percent for individual components and ± 5 percent for groups of components.

T. W. Legatski, J. W. Tooke and L. A. Grundy
Phillips Petroleum Company
Bartlesville, Okla.

SINCE THE DEVELOPMENT of low temperature fractional distillation analysis, few new schemes for determining the hydrocarbon composition of natural gas have been advanced, and, to our knowledge none yet equals low temperature fractionation in precision and reliability. In the intervening 28 years thousands of natural gas compositions have been determined. Seemingly, each sample is a separate problem, unrelated to any other, even though the samples may come from the same producing formation. This apparent random nature has frustrated all efforts to characterize natural gases by simple tests. No test performed on the total gas appears to indicate hydrocarbon composition except in a most general manner. This is understandable when one considers the large number of possible combinations in a mixture containing not less than twelve compounds and possibly up to fifty or more.

Notwithstanding the large number of possible combinations, naturally occurring gases do follow a pattern. There is always more methane present than ethane. Usually there is more ethane present than propane, more propane than butane, more butane than pentane, and so on. Each successively heavier hydrocarbon normally occurs in a lesser amount than its next lighter homologue.

Development

Some time back a study was made in an effort to fit this pattern into an orderly system. It had been noticed that Walton[1] succeeded in plotting true boiling point curves for crude oils as a straight line. He used a graph which had a probability scale for the abscissa and the reciprocal of the absolute distillation temperatures as the ordinate and plotted cumulative volume percent distilled. If the shape of a crude oil distillation curve is compared to the shape of a natural gas distillation curve it will be noticed that the gas distillation curve resembles the last half of the crude oil distillation curve. With this clue a graph was prepared which had as its abscissa the last half of a probability scale.

The graph that was developed is shown in Figure 1. The ordinate is an empirical scale developed through experience and is shown here as a single line for each component or each group of components having the same molecular weight. The ordinate scale, although an empirical one, is closely related to the reciprocal of the absolute boiling point of the compounds.

Findings: During the course of the study no means of distinguishing between isomeric and normal hydrocarbons of the same molecular weight was discovered. For this reason all hydrocarbons having the same molecular weight were put in a group such as iso and normal butane which are grouped as butane. Also during the course of the study it was found that to compare one gas with another the comparison must be made on a non-hydrocarbon or inert free basis. The occurrence of non-hydrocarbons or inerts such as nitrogen, carbon dioxide and hydrogen sulfide in natural gas follows no pattern as far as could be determined.

If gas analyses are plotted on this graph they fall in straight or nearly straight lines. Experience has indicated that whenever a gas analysis fails to plot as a straight line, a recheck

Original presentation as "Estimation of Hydrocarbon Composition of Natural Gas from Absorption Index and Specific Gravity" at the 32nd Annual Convention of NGAA, Houston, April 30, 1953.

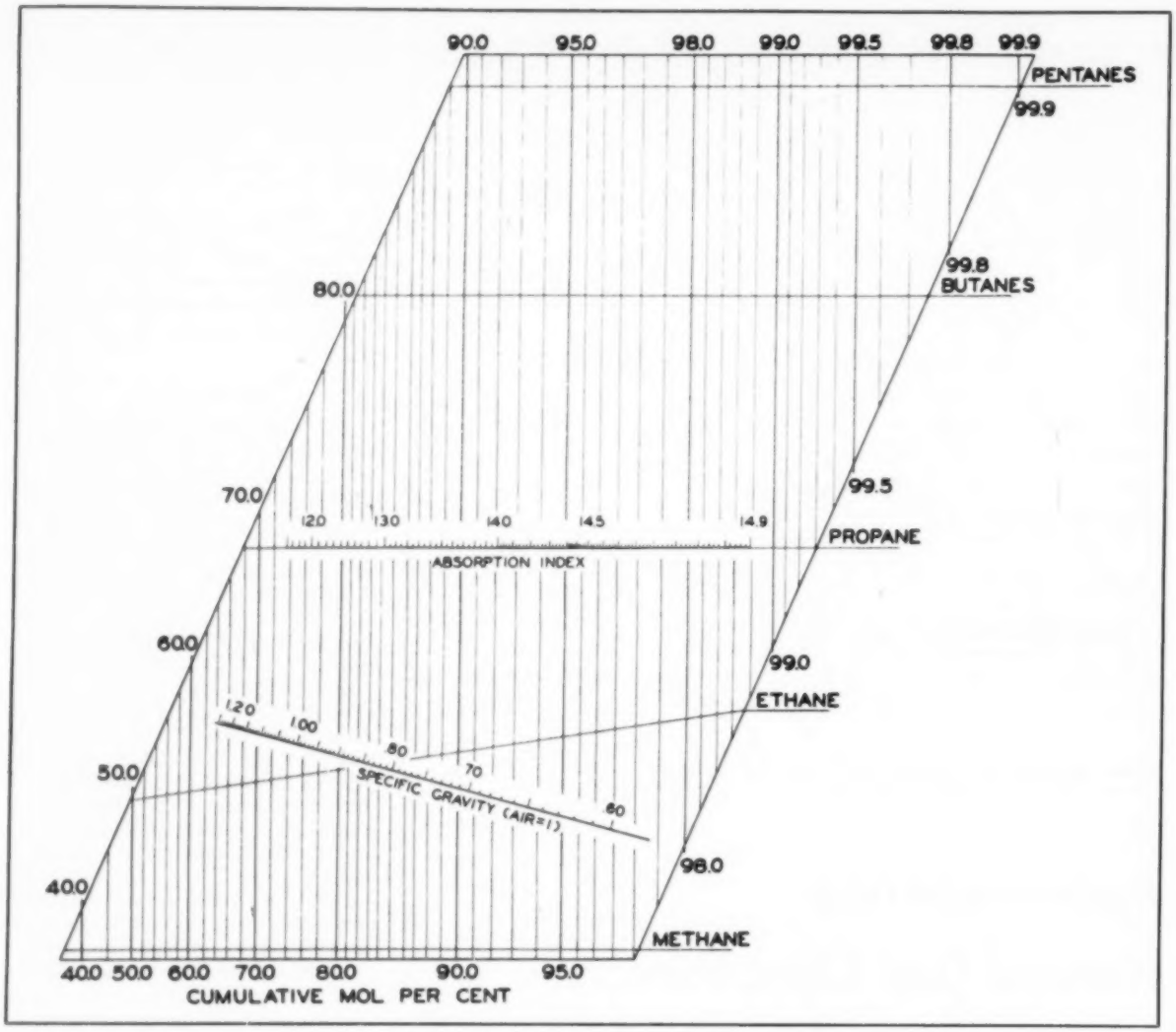


Figure 2. Chart for the graphical analysis of natural gas.

of the analysis invariably indicates that the analysis was in error.

To illustrate the behavior of natural gases there have been selected the "most reproducible analysis" for Gas Samples 3, 4, and 5 from the Natural Gasoline Association of America cooperative program on low temperature fractional analysis. These analyses are reported in the "Proceedings" of the Association for 1941 and are given in Table 1.

From 11 to 15 laboratories throughout the natural gasoline industry cooperated in running these samples and arriving at the "most reproducible analysis" for each. In preparation for plotting on the previously described graph the analyses were converted to cumulative mole percent as shown in the table.

Procedure: To plot a gas analysis, a point is placed on the methane line at the mole percent of methane present. Next a point is placed on the ethane line at the mole percent of ethane plus methane. Another point is placed on the propane line at the mole percent of propane plus ethane plus methane. Points are also placed on the butane and pentane lines following the same procedure. The three NGAA gas analyses are shown plotted in this manner in Figure 1. All three of the samples fall on essentially straight lines. A large number of gas samples have been plotted on a graph such as this, and as yet none has been found which are seriously off from a straight line unless there was an error in the gas analysis.

These illustrations serve to demonstrate that gas analyses can be plotted as straight lines. This being true then it is logical to postulate that characterization factors on the total gas may be used to locate and determine the slope of the line representing the gas.

TABLE 1

NGAA Cooperative Gas Samples—Most Reproducible Analysis

	SAMPLE No. 3		SAMPLE No. 4		SAMPLE No. 5	
	Mol Percent	Cumulative Mol Percent	Mol Percent	Cumulative Mol Percent	Mol Percent	Cumulative Mol Percent
Methane	62.07	62.07	90.35	90.35	67.56	67.56
Ethane	9.69	71.76	4.33	94.68	13.33	80.89
Propane	12.40	84.16	1.90	96.58	10.77	91.66
Butanes	8.96	93.12	1.46	98.04	4.91	96.57
Pentanes	3.86	96.98	0.89	98.93	1.76	98.33
Hexanes Plus	3.02	100.00	1.07	100.00	1.67	100.00

Two characterization factors are necessary. One such factor must be predominently influenced by the light compounds in the gas and the other must be influenced by the heavier compounds. Specific gravity is a potential characterization factor. It is predominently influenced by the methane contained in the gas. From the intersection of lines representing average and near average gas compositions it was possible to construct and calibrate a scale for specific gravity. This was placed on the graph so that when a gas analysis was plotted its specific gravity could be determined by the intersection of its line with the specific gravity scale.

It has been shown that absorption index is directly related to the butane and heavier content of natural gases. It is thus a characterization factor determined on the total gas that is predominently influenced by the high molecular weight compounds.[2] An absorption index scale was located and calibrated on the graph following the same procedure as used for the specific gravity scale. A plot of a gas analysis on the chart now yielded absorption index in addition to specific gravity. The graph with the specific gravity and absorption index scales is shown in Figure 2. It is evident that if these two values are known they may be located on their respective scales and a straight line passing through the two values will then indicate the probable composition of the natural gas under consideration.

Effect of Non-Hydrocarbon Diluents

In developing the chart shown in Figure 2, all studies were confined to gases which were known to be free of non-hydrocarbon constituents or to gases which contained a known amount of non-hydrocarbons. The absorption index is only slightly affected by non-hydrocarbons which may be present in a gas. The effect is so small that for practical purposes it may be ignored. On the other hand, the specific gravity of a gas is largely influenced by the amount of non-hydrocarbon it may contain. In order to use specific gravity with this scheme of estimation the amount of non-hydrocarbon contained in a gas must be known and this quantity taken into account before applying specific gravity to the chart.

The usual non-hydrocarbons found in natural gases are carbon dioxide, hydrogen sulfide and nitrogen. The determination of carbon dioxide and hydrogen sulfide may be readily made by established methods. These compounds may also be removed from a sample under test by passing the sample through an ascarite tube. These constituents then present no problem as the extent of their presence may be determined and they are easily removed before a test is made.

The occurrence of nitrogen in a natural gas presents more of a problem. There is no convenient means for either removing nitrogen or for determining its concentration. Before graphical analysis can be applied to samples containing nitrogen the concentration of nitrogen should be known.

If the non-hydrocarbon concentration in a natural gas is known then the specific gravity may be "corrected" to a non-hydrocarbon free basis by applying the following formula:

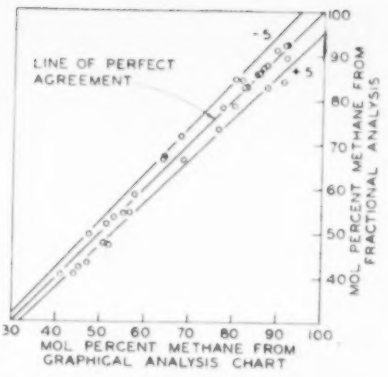


Figure 3. Comparison of graphical vs. fractional analysis for methane.

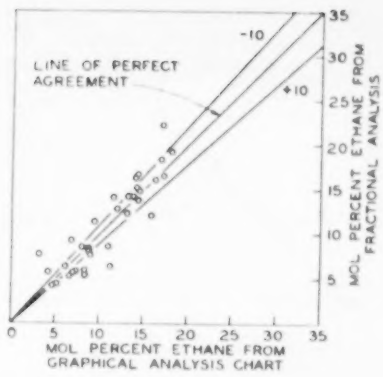


Figure 4. Comparison of graphical vs. fractional analysis for ethane.

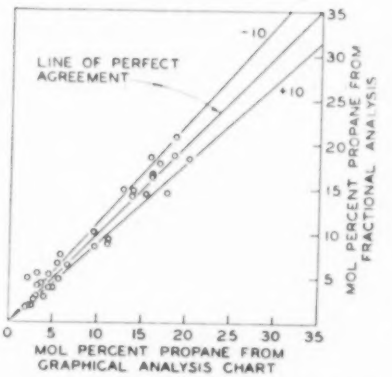


Figure 5. Comparison of graphical vs. fractional analysis for propane.

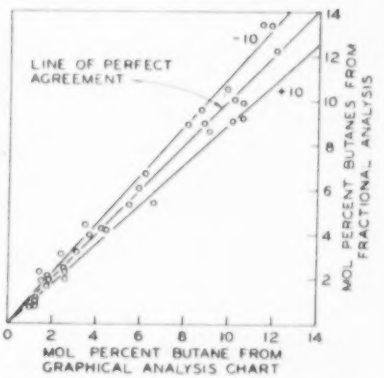


Figure 6. Comparison of graphical vs. fractional analysis for butanes.

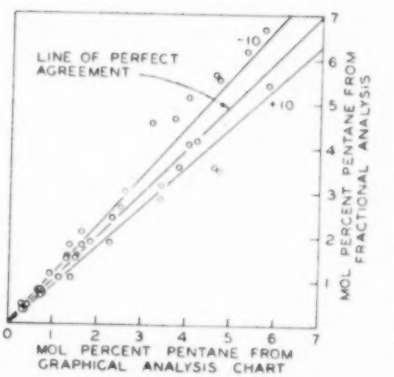
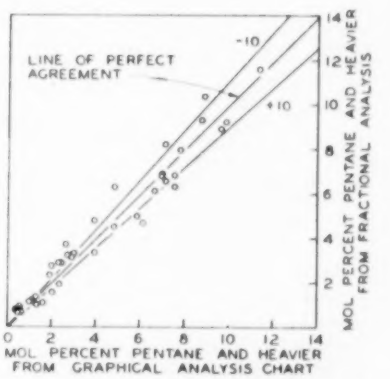


Figure 7. Comparison of graphical vs. fractional analysis of pentane.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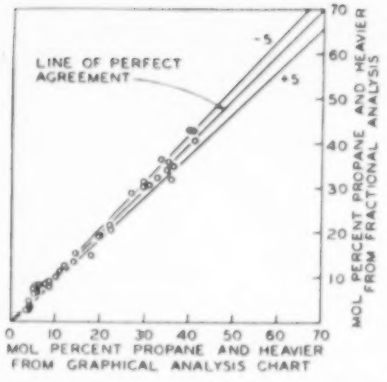
MOL PERCENT PENTANE AND HEAVIER FROM GRAPHICAL ANALYSIS CHART
MOL PERCENT PENTANE AND HEAVIER FROM FRACTIONAL ANALYSIS

Figure 8. Comparison of graphical vs. fractional analysis of pentanes and heavier.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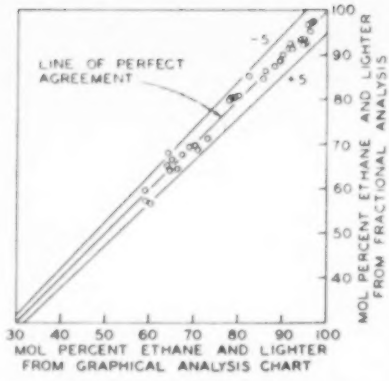
MOL PERCENT PROPANE AND HEAVIER FROM FRACTIONAL ANALYSIS
MOL PERCENT PROPANE AND HEAVIER FROM GRAPHICAL ANALYSIS CHART

Figure 9. Comparison of graphical vs. fractional analysis for propane and heavier.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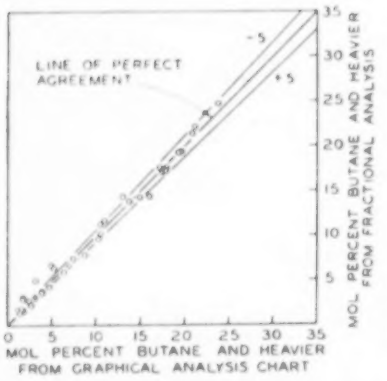
MOL PERCENT ETHANE AND LIGHTER FROM FRACTIONAL ANALYSIS
MOL PERCENT ETHANE AND LIGHTER FROM GRAPHICAL ANALYSIS CHART

Figure 10. Comparison of graphical vs. fractional analysis for ethane and lighter.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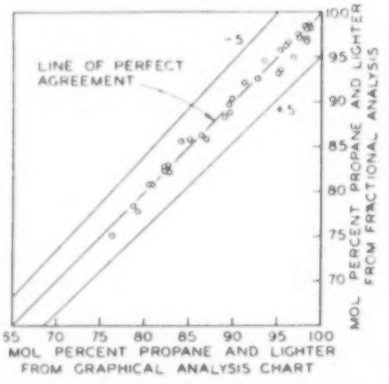
MOL PERCENT BUTANE AND HEAVIER FROM FRACTIONAL ANALYSIS
MOL PERCENT BUTANE AND HEAVIER FROM GRAPHICAL ANALYSIS CHART

Figure 11. Comparison of graphical vs. fractional analysis for butane and heavier.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MOL PERCENT PROPANE AND LIGHTER FROM FRACTIONAL ANALYSIS
MOL PERCENT PROPANE AND LIGHTER FROM GRAPHICAL ANALYSIS CHART

Figure 12. Comparison of graphical vs. fractional analysis for propane and lighter.

$$y = \frac{100z - kx}{100 - x}$$

where y = "corrected" specific gravity
z = observed specific gravity
x = mole percent of non-hydrocarbon in gas
k = a constant whose value depends on the non-hydrocarbon present

For nitrogen	k = 0.97
For carbon dioxide	k = 1.52
For hydrogen sulfide	k = 1.18
For air	k = 1.00

After "correction" of the specific gravity the corrected value may be applied to the graphical analysis chart. To convert the resultant analysis back to the orginal gas basis containing the non-hydrocarbons, multiply the mole percent of each component by $\frac{100-x}{100}$ where x is the mole percent of non-hydrocarbon in the original gas.

Results

Some limited observations have been made bearing upon the probable average accuracy of this estimation method. The specific gravity, absorption index, and fractional analysis were determined on 34 natural gas samples of widely differing characteristics. These samples have previously been described as to sources, ranges in composition and non-hydrocarbon content.[2] A deliberate effort was made to obtain extremes in hydrocarbon composition and in nitrogen content.

The data taken on these 34 natural gas samples were used to estimate the hydrocarbon composition. The observed value for absorption index for each sample was located on the absorption index scale of the graphical analysis chart. The observed specific gravity was "corrected" for any non-hydrocarbon which the sample contained and the "corrected" specific gravity for each sample was then located on the specific gravity scale. The estimated composition was then arrived at from the various intercepts.

The compositions obtained in this manner were compared with the compositions obtained by fractional analysis. These comparisons for each component are shown in Figures 3 through 8. The value for the component which was estimated was located on the abscissa and the corresponding value determined by fractional analysis was located on the ordinate. If these two values were the same they would fall on a 45° line which would represent perfect agreement. The lines on either side of the 45° line represent various percentages removed from the condition of perfect agreement.

If groups of compounds such as "propane and heavier" are compared, the precision of estimation is increased. This is shown in Figures 9 through 12 which indicate that the estimated values are within ±5 percent of that determined by fractional analysis.

These comparisons have been given on a non-hydrocarbon free basis. The same comparisons may be made for these samples containing the original amount of non-hydrocarbon with equal precision. It has already been mentioned that the amount of nitrogen, if any, contained in a gas should be known and taken into account before the observed specific gravity is used. However, small concentrations of nitrogen affect the results to a minor degree, and, for some purposes, failure to "correct" for this need not invalidate results. The magnitude of error caused by small concentrations of nitrogen is shown in Table 2. The estimated composition of two samples are given both "uncorrected" and "corrected" for the amount of nitrogen they contain.

It should be understood that this method of estimating hydrocarbon composition of natural gases is based on averages and only approximates true composition. This approximation is in general with ± 10 percent of the true value for any component and within ± 5 percent of the true value for groups of components. Any method based on statistics will inevitably find cases which do not fit the rules. While such exceptions have not been encountered in this series of tests, these exceptions should be expected and anticipated.

TABLE 2
Effect of Small Concentration of Nitrogen on Graphical Analysis Results

	Estimated Composition, Mol. Percent			
	SAMPLE 11 (3.61 Mol. % N_2)		SAMPLE 25 (1.92 Mol. % N_2)	
	Uncorrected	Corrected For Nitrogen	Uncorrected	Corrected For Nitrogen
Methane	79.7	81.7	55.0	55.5
Ethane	9.7	8.3	13.8	14.5
Propane	5.6	5.0	14.6	13.9
Butanes	3.3	3.1	9.2	9.1
Pentanes Plus	1.7	1.9	7.4	7.0

REFERENCES

[1] Walton, Refiner and Natural Gasoline Manufacture, Vol. 16, No. 1.

[2] Legatski, Tooke and Grundy, Absorption Index—A Simple Test for An Important Property of Natural Gas, presented at the 32nd Annual Convention, Natural Gasoline Association of America, Houston, 1953.

Add these fine points to

LTFD Calculation Procedures

- **Accurate procedures are derived for calculation of analyses on manual, semi-automatic and automatic equipment.**
- **Vapor holdup and gas compressibility corrections are included to improve over-all accuracy.**
- **Design calculations for compensating taper on automatic equipment show development of factors needed for multiple receivers.**

S. T. Preston, Jr.,
NGAA School of Low Temperature Analysis,
University of Oklahoma, Norman

ALTHOUGH DIFFERENCES IN analytical results between laboratories are usually due to errors in technique, variations in calculation procedures have contributed to the discrepancies. It is essential that the calculations be correctly derived from accurate apparatus calibrations and applicable physical laws to obtain the nearest approach possible with the analytical method toward absolute accuracy. The development of a uniform calculation method is one of the objectives of the NGAA school. Standardization of calculation procedures throughout the industry is a step toward better reproducibility between laboratories.

Calculation methods applicable to all types of low temperature equipment are presented herein with the derivation of all equations used. The general use of "vapor holdup" corrections and compressibility factors appears to be highly desirable.

Basic Relationships

The calculation of mole percent is based on the general gas equation:

$$PV = ZnRT \qquad (1)$$

which when rearranged is:

$$n = \frac{PV}{ZRT} \qquad (2)$$

Under conditions of constant volume and temperature, Equation (2) becomes:

$$n = k\left(\frac{P}{Z}\right) \qquad (3)$$

To calculate the volume of gas added to a partially filled receiver, Equation (3) must be modified to:

$$\Delta n = k\left(\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right) \qquad (4)$$

where

P = absolute pressure (receiver)
T = absolute temperature (receiver)
V = volume of system (receiver)
n = number of moles
Z = compressibility factor
R = gas law constant
k = a constant

Subscripts 1 and 2 refer to initial and final conditions.

The relationship expressed in Equation (4) indicates that the number of moles of a gas added to a constant volume, constant temperature receiver, is directly proportional to the final receiver pressure minus the initial receiver pressure, divided by the appropriate compressibility factors for the gas in the receiver. The composition of a gas (in mole percent) may therefore be computed by the use of Equation (4) above, or—

$$\text{Mole percent of component A} = \frac{\left(\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right)_A}{\Sigma\left(\frac{P}{Z}\right)} \qquad (5)$$

In order to simplify the application of holdup corrections and the conversion to a liquid volume percent basis, it is customary to calculate the volume each component would occupy at some reference standard conditions, *if the component behaved as a perfect gas at the reference conditions.* The standard conditions generally used are (a) 760 mm and 60 F., or (b) 760 mm and 0 C.

Using the subscript (R) to designate receiver conditions and the subscript (S) to designate standard conditions, Equation (4) may be written as:

$$\Delta n = \left(\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right)_R \frac{V_R}{RT_R} = \frac{P_S}{RT_S}(V_S) \qquad (6)$$

Note the compressibility factor corresponding to the standard conditions is missing in Equation (6) because the volume V_S is a perfect gas volume ($Z_S = 1.000$). Solving Equation (6) for V_S gives:

$$V_S = V_R \times \left(\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right)_R \times \frac{1}{P_S} \times \frac{T_S}{T_R} \qquad (7)$$

Selecting 760 mm and 60 F. as the standard conditions, Equation (7) becomes:

$$V_R \times \left(\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right) \times \frac{288.72}{760} \times \frac{1}{T_R} = \text{Gas volume at 760 mm and 60° F.} \qquad (8)$$

Since most analytical units are equipped to read temperatures in de-

Figure 1A

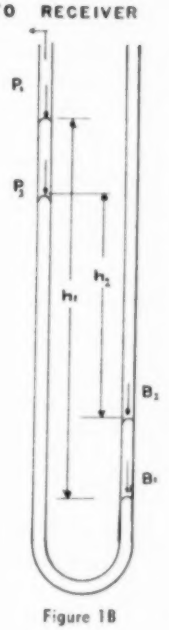

Figure 1B

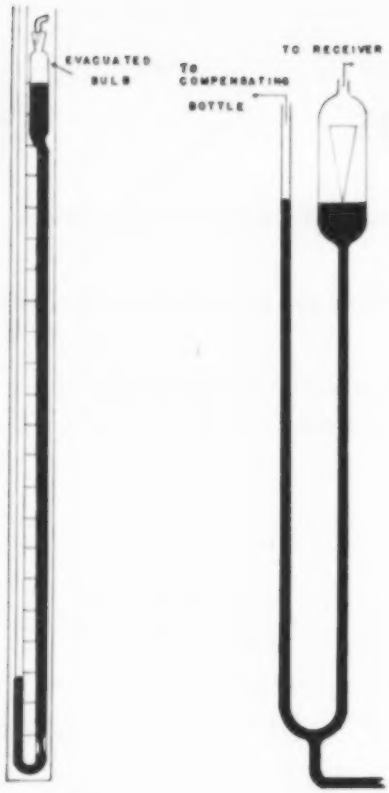

Figure 2

Figure 3

grees centigrade, the temperatures used in Equation (8) are expressed in degrees Kelvin, (°K = 273.16 + °C), (60 F. = 15.56 C.).

Equation (8) is the basic relationship used to compute the results of low temperature analysis on *all* types of equipment.

Compressibility Factors

There are essentially three methods of considering compressibility factors in the calculation of analytical results.

FIRST: Compressibility factors may be taken as unity for all components. This assumption of "perfect gas" behavior results in the simplification of Equations (5) and (8) to:

$$\text{Mole percent of component A} = \frac{(\Delta P)_A}{\Sigma P} \qquad (5a)$$

$$V_R \times \frac{\Delta P}{760} \times \frac{288.72}{T_R} = \text{Gas volume at 760 mm and 60 F.} \qquad (8a)$$

By strict observation of predetermined receiver pressure limits and by adding only one component to each receiver, the error caused by the omission of compressibility factors may be limited to 1 percent of the measured component. The addition of several components to a single receiver causes compounding of the errors.

SECOND: Compressibility factors based on the partial pressure of a component may be used to improve the accuracy of the first method. If each component is added to a separate receiver, this method of calculation will give precise results. Mixing of components in a single receiver again results in compound errors, consequently this is an approximation method for mixtures. Using this method, Equations (5) and (8) become:

$$\text{Mole percent of component A} = \frac{\left(\frac{p}{Z}\right)_A}{\Sigma\left(\frac{p}{Z}\right)} \qquad (5b)$$

$$V_R \times \left(\frac{p}{Z}\right) \times \frac{288.72}{760} \times \frac{1}{T_R} = \text{Gas volume at 760 mm and 60 F.} \qquad (8b)$$

where p = partial pressure of component
Z = compressibility factor corresponding to p

THIRD: Calculations using compressibility factors based on the total receiver pressure and receiver composition are precise (to the extent to which the compressibility factors are known). The factors (Z_1 and Z_2) required for use in Equations (5) and (8) are based on the initial receiver pressure and composition, and the final receiver pressure and composition. Calculation by this method is necessary when two or more components are added to the same receiver. Automatic equipment is made less automatic if the operator is required to change receivers with each new component, consequently this precise method of calculation is recommended to eliminate errors due to the non-ideal gas behavior. According to the findings of Jessen and Lightfoot[2,3] compressibility factors for binary gas mixtures may be estimated by interpolation with a fair degree of accuracy. Compressibility factors for mixtures of more than two components may be estimated by calculating the sum of the products of the mole fraction of each component in the receiver and its compressibility factor,[1] or—

$$Z_m = n_A Z_A + n_B Z_B + n_C Z_C \ldots \qquad (9)$$

where Z_m = mean compressibility factor
n = mole fraction of component A, B, C, . . . in receiver

Automatic Column

Sample L. P. G. Analyzed by _____ Date _____

Barometer 730.0 at 0 °C, Receiver temp. 37.78 °C, Manometer temp. 80. °F

Component	Chart Travel * (in div.)	Z	$\frac{CT}{Z}$	$\left(\frac{CT}{Z}\right)_{2-1}$	Gas Volume ml at 60°F	Holdup +	Holdup −	Corrected Gas Volume
C_3	25.	.999	25.0	25.0	71.0	12.4		83.4
iC_4	825.	.986	836.7	811.7	2306.0	12.2	12.4	2305.8
nC_4	900.	.984	914.6	77.9	221.3	-	12.2	209.1
nC_4	10.**	1.000	10.0	10.0	28.4	-	-	28.4

* Measured from the beginning of each new receiver.
** In New Receiver

	Corrected Gas Volume	Mole Percent Inerts Free	Mole Percent	Liquid/Gas Ratio	Liquid Vol. ml at 60°F	Liquid Vol. Percent
Inerts			—			
C_1				.002259		
C_2				.003397		
C_3	83.4	3.18	3.18	.003670	0.306	2.69
iC_4	2305.8	87.78	87.78	.004361	10.056	88.52
nC_4	237.5	9.04	9.04	.004202	0.998	8.79
iC_5				.004879		
nC_5				.004830		
nC_6				.005483		
nC_7				.006152		
Total	2626.7	100.00			11.360	100.00

Gas Volume at 760 mm and 60°F = 887.64 x $\left(\frac{F}{T}\right)$ x $\left(\frac{CT}{Z}\right)_{2-1}$ = 2.8409 $\left(\frac{CT}{Z}\right)_{2-1}$

CT = divisions, T = Receiver temp. (273.16 + °C), F = Manometer temp. correction
Z = Compressibility factor

Figure 4. Low temperature fractional analysis data sheet.

Z = compressibility factor of individual components at receiver temperature and pressure

The relationship of Equation (9) may be simplified to:

$$Z_m = p_A Z_A + p_B Z_B + p_C Z_C \qquad (9a)$$

As an illustration of the effect of compressibility factors on analytical results, consider the two cases: (a) The addition of iso-butane to a completely evacuated receiver to a pressure of 400 mm (receiver temperature = 100 F.); and (b) The addition of isobutane to a receiver already containing propane at 200 mm pressure, to a final receiver pressure of 400 mm. In case (a) the pressure term of Equation (8) becomes:

(1) 400 mm
(2) 400/.9877 = 405.0 mm
(3) 400/.9877 — 0 = 405.0 mm

by the three methods of applying the compressibility factors. In case (b) the pressure term of Equation (8) becomes:

(1) 200 mm
(2) 200/.9938 = 201.0 mm
(3) 400/.9900 — 200/.9960 = 203.2 mm

by the three methods. Correct answer in each case is underlined.

Manual Equipment

Measurement of the vapor phase components is accomplished by measusing the pressure rise in a "constant volume" receiver at an observed temperature. Receiver pressures are usually measured with an open end, equal bore manometer on manual equipment. Leveling bulb manometers are frequently used to keep the receiver volume constant. The difference in mercury levels within the manometer is a function of (a) receiver pressure, (b) barometric pressure, and (c) the density of the mercury in the manometer. Since measurements of receiver pressure are relative to barometric pressure, fluctuations in the barometer must be considered for accurate measurement of components. Variation in mercury density (manometer temperature) is corrected by reducing the observed mercury height to the height which would have been observed if the mercury temperature were 0 C. (International Standard for pressure measurements). The correction for manometer temperature is:

$$F = \frac{\rho}{\rho'} \qquad (10)$$

where F = manometer temperature correction factor
ρ = density of mercury at temperature of manometer
ρ' = density of mercury at 0 C.

Values of F have been computed from handbook data (Lange's Handbook of Chemistry, p. 1154), and are tabulated in Table 1.

The absolute receiver pressure at any time is equal to the barometric pressure (corrected to 0 C.) minus the difference in mercury levels corrected for mercury density, (See Figure 1a).

$$P = B - (h \times F) \qquad (11)$$

where P = true absolute pressure
B = barometric pressure (corrected to 0 C.)
h = observed difference in mercury levels within the manometer
F = manometer temperature correction factor

Absolute pressures computed from Equation (11) are used in Equation (8) with appropriate compressibility factors for accurate analytical results. Calculations are simplified if each component is added to a completely evacuated receiver ($P_1 = 0$). Under these conditions Equation (8) reduces to:

$$V_R \times \frac{P_2}{Z_2} \times \frac{288.72}{760} \times \frac{1}{T_R} =$$

Gas volume at 760 mm and 60 F. (12)

The pressure, P_2 is given by (See Figure 1b):

$$P_2 = (B_2 - B_1) + (h_1 - h_2) \times F. = \Delta B + (\Delta M \times F.) \qquad (13)$$

The additional condition of contant barometric pressure ($\Delta B = 0$) simplifies Equation (12) to:

$$V_R \times \frac{\Delta M \times F.}{Z_2} \times \frac{288.72}{760} \times \frac{1}{T_R} =$$

Gas volume at 760 mm and 60 F. (14)

The frequently used "bottle factors" are a combination of the constant terms of Equation (8), or:

$$\text{"Bottle factor"} = V_R \times \frac{288.72}{760} \times \frac{1}{T_R} \qquad (15)$$

The preparation of a table of "bottle factors" for all probable values of T_R simplifies the calculation of gas volumes from Equations (8), (12), or (14).

Semi-Automatic Equipment

Measurement of components in semi-automatic equipment differs from that of manual equipment in two respects: (a) Pressure measurements are made with a closed end manome-

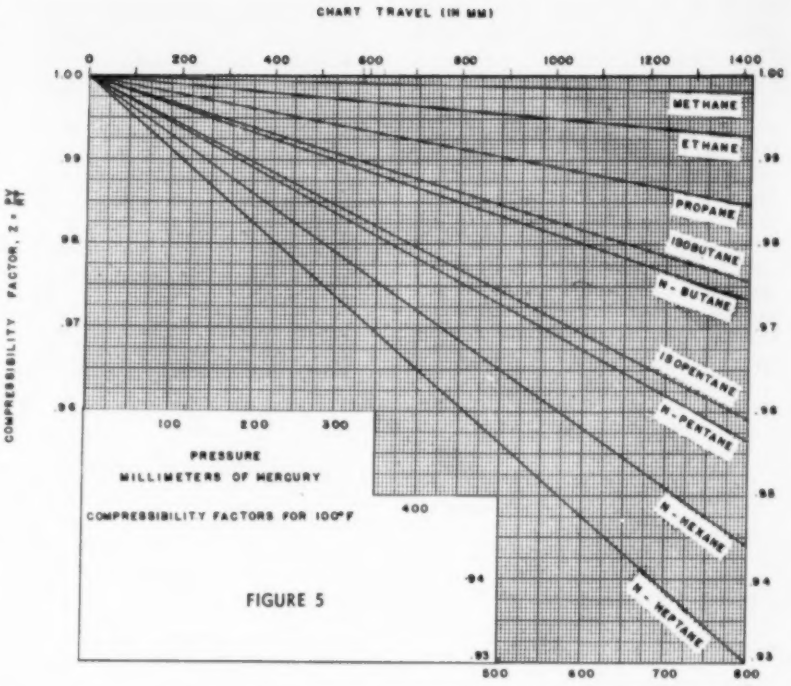

FIGURE 5

TABLE 1
Manometer Temperature Correction Factors

Mano. Temp.	Factor	Mano. Temp.	Factor	Mano. Temp.	Factor	Mano. Temp.	Factor
60 F.	.9972	70 F.	.9962	80 F.	.9952	90 F.	.9942
61	.9971	71	.9961	81	.9951	91	.9941
62	.9970	72	.9960	82	.9950	92	.9940
63	.9969	73	.9959	83	.9949	93	.9939
64	.9968	74	.9958	84	.9948	94	.9938
65	.9967	75	.9957	85	.9947	95	.9937
66	.9966	76	.9956	86	.9946	96	.9936
67	.9965	77	.9955	87	.9945	97	.9935
68	.9964	78	.9954	88	.9944	98	.9934
69	.9963	79	.9953	89	.9943	99	.9933
						100	.9932

ter; and (b) Receivers are usually maintained at a constant temperature. The closed end manometer (shown in Figure 2) eliminates small errors due to variations of barometric pressure and if constructed of fairly constant bore tubing, permits the reading of a single leg without error. The rise of the mercury in the evacuated chamber is not measured but is taken into consideration by multiplying the readings (ΔM) on the left leg, by a constant factor. Since the volume of mercury displaced from the left leg is exactly equal to the volume entering the evacuated chamber:

Volume of mercury displaced =

$$\left(\frac{\pi d^2}{4}\right)\Delta M = \left(\frac{\pi D^2}{4}\right)h \qquad (16)$$

where d = diameter of left leg
D = diameter of evacuated chamber
h = height of mercury rise in evacuated chamber

Solving Equation (16) for h gives:

$$h = \Delta M\left(\frac{d^2}{D^2}\right) \qquad (17)$$

Since the true pressure rise is the sum of the mercury travel in both legs—

$$\Delta P = \Delta M + h = \Delta M\left(1 + \frac{d^2}{D^2}\right) \qquad (18)$$

Defining a new constant, K, as

$$K = 1 + \frac{d^2}{D^2} \qquad (19)$$

Equation (18) then becomes:

$$\Delta P = \Delta M \times K \qquad (20)$$

As in the case of manual equipment, it is necessary to correct the observed reading for variations in the density of the mercury, or

$$\Delta P = \Delta M \times K \times F \qquad (21)$$

Equation (21) is used to compute the pressures required by Equation (8) for semi-automatic equipment (based on the fact that the distillation is started into a completely evacuated receiver).

The value of K may be determined experimentally, but will usually be found to be etched on the evacuated leg of the manometer. On some manometers the value shown is one half of K (correct value of K is between 1.03 and 1.05 for semi-automatic equipment).

Automatic Equipment

Gas measurements on automatic equipment are accomplished by converting receiver pressure rise to chart travel. A "compensating" bottle is used to shield pressure readings from barometric pressure fluctuations. The manometer used on automatic equipment is shown in Figure 3.

As in the case of semi-automatic equipment, the pressure rise is obtained by correcting the mercury travel (ΔM) for inequality of bore (K) and mercury temperature (F.). As the mercury level rises in the left hand leg, the air in the compensating bottle is compressed, consequently the reference pressure is changed slightly. The total pressure change within the receiver is the sum of the observed pressure change, ($\Delta M \times K \times F$), plus the increase in reference pressure within the compensating bottle. Since the compensating bottle is maintained at a constant temperature, Boyle's law may be applied to calculate the change in reference pressure. A factor, F', may be calculated, which when multiplied by the quantity ($\Delta M \times K \times F$.), corrects for the change in reference pressure. Calculated values of F' vary slightly with barometric pressure as indicated below:

Barometric pressure	F'
767. mm	1.0088
706. mm	1.0081
655. mm	1.0075

The true receiver pressure rise is therefore:

$$\Delta P = \Delta M \times F. \times K \times F' \qquad (22)$$

The mercury travel is related to chart travel by the ratio of the pitch diameter of the drive gear to the diameter of the chart roll, or

$$\frac{\Delta M}{CT} = \frac{1.000}{1.905} \quad \text{or} \quad \Delta M = \frac{CT}{1.905} \qquad (23)$$

Combining Equations (22) and (23) gives:

$$\Delta P = \frac{CT}{1.905} \times F. \times K \times F' \qquad (24)$$

Combining Equations (8) and (24) gives:

$$\text{Gas volume} = V_R \times \frac{288.72}{T_R} \times \left[\left(\frac{CT}{Z}\right)_2 - \left(\frac{CT}{Z}\right)_1\right] \times \frac{F. \times K \times F'}{1.905 \times 760} \qquad (25)$$

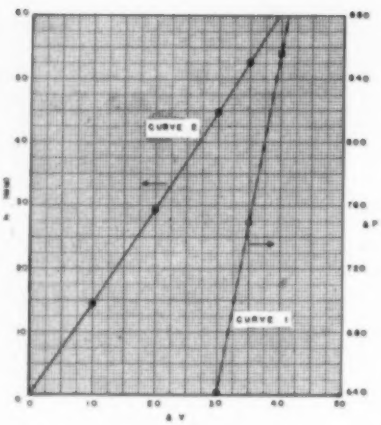

Figure 6

where CT = chart travel in millimeters.

Subscripts (1 and 2) in Equation (25) refer to the initial and final chart travel for a component, as measured from the start of each new receiver.

If chart travel is measured in chart divisions, the following relationship between CT (divisions) and CT (mm) is added to Equation (25):

$$CT\ (div.) \times 1.016 = CT\ (mm) \qquad (26)$$

The factor 1.016 is added to the numerator of Equation (25).

Combining the constant terms of Equation (24), including the conversion for chart travel measured in chart divisions, gives: (Using V_R = 4054.5 ml, K = 1.0711, and F = 1.0088)

$$887.64 \times \left(\frac{F.}{T_R}\right) \times \left(\frac{CT}{Z}\right)_{2-1} = \text{Gas volume at 760 mm and 60 F.} \qquad (27)$$

Calculation of Mole Percent

The calculation of mole percent is illustrated in Figure 4. Corrections for vapor holdup were made to correct for the volume of gas left between the thermocouple and the distillation shut-off valve as indicated previously.[4] The compressibility factors used in this illustrative problem are shown in Figure 5. The data used in the construction of Figure 5 were obtained from a recent article by Silberberg and McKetta,[5] and from the California Natural Gasoline Association Bulletin TS-401, 2nd edition. The chart travel scale was added to Figure 5 to facilitate its use with automatic equipment and is based on the relationship:

$$\Delta P = \frac{1.0711 \times .99637 \times 1.0088 \times CT}{1.905} = 0.56512 \times CT \qquad (28)$$

Calculation of Liquid Volume Percent

The calculation of composition as liquid volume percent, is accomplished by converting the measured vapor volume of each component to the equivalent liquid volume. The vapor volume, as computed from the various modifications of Equation (8), is the "ideal" gas volume at the reference conditions. The conversion factors from vapor to liquid are therefore derived from the general gas law, Equation (1), as applied to ideal gases (Z = 1.000). From this equation the following relationship is obtained:

$$\frac{\text{ml of liquid}}{\text{ml of Gas}} = \frac{M.W.}{23{,}690.4 \times SpGr \times \rho_w} \qquad (29)$$

Where
MW = Molecular weight
23,690.4 = Molal gas volume, where gas is measured at 60 F. (22,414, if gas is measured at 0 C.)

$SpGr^{60}_{60}$ = Specific gravity of hydrocarbon liquid at 60 F. (compared to water at 60 F.)

ρ_w = Density of water at 60 F.

Using Equation (29), the values of the (liquid/gas) ratio, shown in Table 2, were computed for both reference temperatures, using physical constants from the ASTM special Technical Publication # 109 (1950).

The calculation of the composition on a liquid volume percent basis is also shown in Figure 4. This calculation illustrates the type of data sheet needed for calculations by the above procedure and is essentially identical with the one used in the NGAA School of Low Temperature Fractional Analysis.

Compensating Taper—Automatic Equipment

One of the problems frequently encountered by the operators of automatic equipment, is the measurements of gas volumes in receivers other than one-gallon capacity. A knowledge of the design of the compensating taper (See Figure 3) will enable operators to use any size receiver (one liter to five gallon) with appropriate corrections.

In the development of Equation (25), it was assumed that the volume of the receiver system was constant. Actually, the receiver volume increases as the mercury level in the right hand leg recedes. The volume of the receiver reaches a maximum of 4054.5 ml only when the mercury level is at the calibration mark located at the tip of the compensating taper. The change in the receiver volume is about 35.5 ml or almost 1 percent of the total volume. Considering V_R as a variable in Equation (25), it may be seen that the gas volume computed from this equation is also a variable. Since chart travel must be directly proportional to gas volume regardless of the position of the mercury level, it is necessary to vary one other term of Equation (25), to compensate for the variation of V_R. Consequently the term K, is made to vary in such a way that:

$$V_R \times K = \text{a constant} \qquad (30)$$

TABLE 2

Vapor to Liquid Conversion Factors*

	Liquid Gas (60 F.)	Liquid Gas (0 C.)	Cu. Ft. Vapor Gal. Liquid
C_1	(.002259)	(.002388)	(59.17)
C_2	(.003397)	(.003590)	(39.35)
C_3	.003670	.003879	36.43
iC_4	.004361	.004609	30.65
nC_4	.004202	.004441	31.81
iC_5	.004879	.005157	27.40
nC_5	.004830	.005105	27.68
nC_6	.005483	.005795	24.38
nC_7	.006152	.006502	21.73

* Based on ASTM Technical Publication 109. Figures in parentehsis based on NGAA Standard 2145.

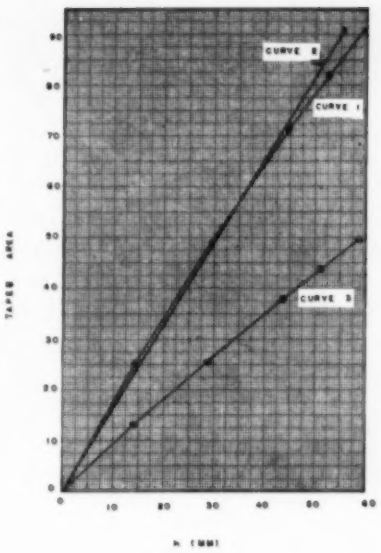

Figure 7

Using the inside diameters of the two legs of the manometer (8 mm and 30 mm) and the volume of the receiver system to the calibration mark, the constant of Equation (30) is computed to be 4342.82 (V_R = 4054.5 and K = 1.0711).

A summary of the design calculations of the compensating taper is presented in Table 3. The calculation may be divided into the following steps:

- Values of V_R less than 4054.5 ml, and in increments of 10 ml are selected as the basis for the calculations.
- The constant K is computed for the various values of V_R using Equation (30).
- The diameter squared is computed from the values of K using Equation (19). This diameter (designated "instantaneous") is the diameter at the mercury level in the right hand leg corresponding to each particular volume, V_R.
- The cross sectional area of the right hand leg is calculated from the values of D^2.
- The change in cross sectional area is computed for each value of V_R, ($\triangle$ area).
- The effective average area is computed for each increment of $\triangle V$, by obtaining an arithmetic average of the area at the top and bottom of each section.
- The incremental change in mercury level ($\triangle h$) corresponding to each increment of $\triangle V$ is computed by dividing the $\triangle V$ by the average area.
- The total change in mercury level (h) from the reference level is the sum of the incremental changes.
- The mercury travel (MT) corresponding to each increment of volume ($\triangle V$) is computed from the first half of Equation (16).
- The total pressure change is computed from the first part of Equation (18).

Using 760 mm ($\triangle P$) as the design basis, the change in receiver volume ($\triangle V$) is found from a $\triangle P$ versus $\triangle V$ curve (Figure 6, curve 1), ($\triangle V$ = 35.52 ml). The change in mercury level, (h) is obtained from a $\triangle V$ versus h curve (h = 53.5 mm at $\triangle V$ = 35.52 ml), (Figure 6, curve 2). The change in cross sectional area at the top of the taper is found, from a $\triangle$ Area versus h curve, to be 83.0 mm (Figure 7, curve 1). The compensating taper, if designed for a pressure change of 760 mm, would be 53.5 mm long and have an area of 83.0 mm at the top. In order to permit pressure changes greater than 760 mm (for areas of high barometric pressure) the compensating taper is made 55.56 mm long ($2^{3}/_{16}$ inches). By making the area at the top of the taper 90.726 mm ($^{3}/_{8}$ x $^{3}/_{8}$ inches) the taper, which is a straight edged wedge, is made to more nearly approximate curve 1 of Figure 7. The relationship between taper area and h is shown as curve 2 of Figure 7.

Calculations similar to those above, for two one-gallon receivers in parallel, resulted in the relationship shown as curve 3 of Figure 7.

Multiple Receivers

The use of several receivers in parallel is desirable for the measurement of large quantities of methane in dry gases. Gas measurement in receiver systems larger than 4054.5 ml requires a correction factor for two reasons:

TABLE 3

Calculations of the Compensating Taper

(1) $\triangle V$	(2) V	(3) K	(4) D^2 (Instantaneous)	(5) Instantaneous Area	(6) $\triangle$Area	(7) Effective Ave. Area	(8) $\triangle h$	(9) h	(10) MT	(11) $\triangle P$
0	4054.5	1.071111	900.0000	706.8578	0	694.1680	0	0	0	0
10	4044.5	1.073759	867.6858	681.4783	25.379	669.6116	14.406	14.406	198.94	213.346
20	4034.5	1.076421	837.4677	657.7450	49.113	646.6240	14.934	29.340	397.88	427.220
30	4024.5	1.079095	809.1482	635.5030	71.3548	630.2004	15.465	44.805	596.83	641.635
35	4019.5	1.080438	795.6453	624.8978	81.960	619.7368	7.934	52.739	696.30	749.039
40	4014.5	1.081783	782.5537	614.6157	92.242		8.068	60.807	795.77	856.577

(1) The volume of two receivers in parallel is less than twice the volume of a single receiver.

(2) The compensating taper is designed for use with a single receiver.

The calculation of these correction factors is summarized in Table 4, for 2, 3, 4 and 5 receivers in parallel. The actual taper area is computed from the relationship of curve 2, Figure 7, which is based on the manufacturer's specifications. From the taper area, the actual K is computed corresponding to each increment of volume change (ΔV). The $V \times K$ product for all combinations of receivers is computed and divided by the constant 4342.82, on which all measurements are based. The resulting factors given in columns 18, 19, 20 and 21 of Table 4 convert chart travel in multiple receivers to the equivalent chart travel in a single receiver. The factor corresponding to $\Delta V = 0$ should be used if the multiple receivers are filled to atmospheric pressure. Variations in these factors are sufficiently small to justify the use of a single value or an average figure.

One Liter Receiver

In the measurement of components present in the sample in very small quantities (propane and butanes of dry gases), a small receiver is desirable. The compensating taper was designed to correct for a variation of 35.5 ml in receiver volume (about 1 percent of a one-gallon receiver). In a 1000 ml receiver system this variation is almost 4 percent and must be considered in a different way.

The relationship between receiver volume and K is summarized in Table 5, for a 1000 ml receiver. The chart travel (CT) is computed from MT, using Equation (23). The variation in the factor of column 27 is sufficiently large to prohibit the use of an average value.

The following method has been used successfully in the NGAA School of Low Temperature Analysis:

(1) Values of $(V \times K)$ are plotted against MT (curve 1 of Figure 8) and CT (curve 2 of Figure 8).

(2) A scale is prepared from the MT versus $V \times K$ curve, showing all even values of the $V \times K$ product. The reference mark on the scale is designated by $V \times K = 107.11$. All other values of $V \times K$ are located along the scale according to the distance (MT) indicated by curve 1 (Figure 8).

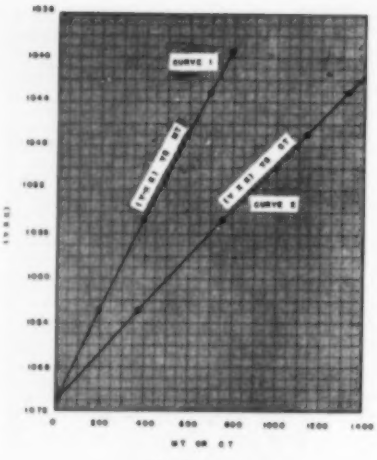

Figure 8

TABLE 5

ΔV	(22) Actual V	(23) Actual K	(24) (V x K) 1 L. Rec.	(25) MT	(26) CT	(27) (V x K) 4342.82
0	1000	1.071111	1071.11	0	0	0.24664
10	990	1.073559	1062.82	198.94	378.98	0.24473
20	980	1.076281	1054.76	397.88	757.96	0.24287
30	970	1.079321	1046.94	596.83	1136.96	0.24107
35	965	1.080976	1043.14	696.30	1326.45	0.24020
40	960	1.082732	1039.42	795.77	1515.94	0.23934

(3) A second scale is prepared based on the relationship between $(V \times K)$ and CT. The reference mark is designated as 1071.11 and all even values of the $(V \times K)$ product are located along the scale according to the distance (CT) indicated by curve 2 (Figure 8).

(4) The scale prepared in (2) above is mounted behind the left hand leg of the receiver manometer with reference mark level with the calibration mark of other leg.

When gas is to be measured in a one liter receiver the chart is marked and the $V \times K$ product is read from the scale mounted in (4) above is noted on the chart. Upon completion of the analysis the scale prepared in (3) above is placed on the chart in such a position that the $V \times K$ product noted on the chart, is opposite that $V \times K$ product on the scale. The $V \times K$ product at all cut-points may then be read from the scale.

Rearranging Equation (25) gives:

$$(V_R \times K) \times \frac{288.72 \times F \times F' \times 1.016}{T_R \times 1.905 \times 760} \times \left(\frac{CT}{Z}\right)_{2-1} = \text{Gas volume} \quad (31)$$

from which the correct gas volume may be computed for any value of $V \times K$ as read from the scale.

Although the description of this method may appear somewhat formidable, in practice the scales required may be prepared by the manufacturer, thereby simplifying measurements in small receivers to chart measurements with the appropriate scale and substitution in Equation (31).

Appraisal of Factors

Although precise analysis would require the use of the various factors described herein, inspection will reveal that certain factors contribute very little to the accuracy of the analysis. Average values of the manometer temperature correction factor F., and compression correction, F.′ should be combined into the constant term of Equation (27). Errors due to the omission of the manometer temperature correction are insignificant and probably beyond the accuracy of the method. The use of average values of the correction for multiple receivers is also justified on the same basis.

Summary

The basic relationship required for the calculation of results of low temperature fractional analysis is derived [Equation (8)]. The modifications of this basic equation needed for the various types of equipment are developed.

Although several different models of the automatic column are in use, an understanding of the relationships presented will permit the application of these equations to any equipment.

The calculations of the compensating taper presented herein constitute an independent check on those originally developed by Dr. W. J. Podbielniak.

TABLE 4

Multiple Receiver Calculations

ΔV	(12) Taper Area	(13) Actual Area	(14) D² (Actual)	(15)[5] Actual K	(16) V (2 Rec.)	(17) V x K (2 Rec.)	(18) 2 Rec. V x K 4342.82	(19) 3 Rec. V x K 4342.82	(20) 4 Rec. V x K 4342.82	(21) 5 Rec. V x K 4342.82
0	0	706.8578	900.0000	1.071111	8031.5	8602.629	1.9809	2.9618	3.9427	4.9235
10	23.523	683.3348	870.0496	1.073559	8021.5	8611.554	1.9829	2.9661	3.9492	4.9323
20	47.908	658.9498	839.0016	1.076281	8011.5	8622.625	1.9855	2.9711	3.9567	4.9423
30	73.160	633.6978	806.8498	1.079321	8001.5	8636.187	1.9886	2.9770	3.9654	4.9538
35	86.115	620.7428	790.3549	1.080976	7996.5	8644.025	1.9904	2.9803	3.9703	4.9602
40	99.289	607.5688	773.5813	1.082732	7991.5	8652.653	1.9924	2.9839	3.9755	4.9670

ACKNOWLEDGMENTS

The author wishes to express his appreciation for the critical review and suggestions given by Dr. W. J. Podbielniak, Podbielniak, Inc., and Joe Wood, Skelly Oil Company.

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SPOT NUMBER _____ **ANALYSIS OF A GAS SAMPLE** DATE SAMPLED _____

SAMPLE OF _____ DATE ANALYZED _____

FRACTION	Mm. Chart Travel or Mm. Pressure: Includes Air	Mm. Chart Travel or Mm. Pressure: Air Free	Mm. Chart Travel or Mm. Pressure: Includes CO_2 & H_2S	CONSTITUENT OF FRACTION	Percentage of Constituent in Fraction: Includes Air	Percentage of Constituent in Fraction: Air Free (C)	Mol. % (Gas Vol. %) of Each Constituent = S.x.C. / B or S.x.C. / B_1 (D)	D x Mol. Wt. of Each Constituent (E)	Wt. % of Each Constituent = E x 100 / F (G)	Sp. Gr. (W.) of Each Constituent = G / (H)	Liq. Vol. % of Each Constituent = H x 100 / I (J)	Cu. Ft. Constituent/Day = DxZ / 100 (K)	Bbls. Constituent/Day = J x T / 100 or Ks / Cu. Ft. Const.
Acid Gases		(S)		Hydrogen Sulfide		0.0							
				Carbon Dioxide		0.0							
C_1		164		Carbon Monoxide		0.0							
				Oxygen		0.0							
				Nitrogen		0.0							
				Hydrogen		0.0							
				Methane		100.0	51.0	818	26.9	101.9	43.4	510.000	
C_2	314			Ethylene	37.4	6.9	194	6.4	15.6	6.2	69.000		
				Ethane	62.6	11.6	349	11.4	30.2	12.0	116.000		
C_3	216			Propylene	39.1	5.0	210	6.9	13.2	5.3	50.000		
				Propane	60.9	7.8	344	11.3	22.2	8.8	78.000		
C_4	177			Butene—1 } Butene—2 }	19.1	2.0	112	3.7	6.1	2.4	20.000		
				iso-Butylene	15.0	1.6	9.0	2.9	4.8	1.9	16.000		
				iso-Butane } n-Butane }	65.9	6.9	401	13.2	23.0	9.2	69.000		
C_5	108			Amylenes	31.4	2.0	140	4.6	7.0	2.8	20.000		
				iso-Pentane } n-Pentane }	68.6	4.4	317	10.4	16.6	6.6	44.000		
Liq. Rcs.	13 †	†			100.0	0.8	69	2.3	3.5	1.4	8,000		
Sum	1692 (B)*	(B₁)*				100.0	3044 (F)	100.0	251.1 (I)	100.1	1,000.000		

Production 1,000,000 (Z) Cu. Ft./Day

_____ (Y) Bbls./Day

Mol. Wt. of Sample = F / 100 = 3044

Density (A) = F / 2896 = 1.051

Density (W) = 100 / I = 0.3982

Apparatus (No. 1) No. 2; No. 3; No. 4; No. 5

Vol. of Liq. Res. 0.6 Mls.

Analysis Temp. 25 °C.

*(B) & (B_1) — Air Free Basis

†Chart Travel of Liq. Res. =

Liq. Mls. Residue x (273 + °C) / 0.00549 x Factor for Pod.

Pod Factors:

2459.4 for No. 1 Pod

823 for No. 2 Pod

1464.5 for No. 3 Pod

1429.7 for No. 4 Pod

1527.4 for No. 5 Pod

Figure 1. Sheet No. 1 of operator's form.

Save LTFD Calculation Time With These Sheets

These forms also standardize the procedure and shorten training periods.

W. F. Krause, A. C. Dystrup, K. A. Buchanan, Globe Oil & Refining Company, Lemont, Ill.

TIME CAN BE SAVED in the common practice which uses chemists as operators of low temperature fractionation equipment for analysis of gases. Usually these men obtain their own samples, make the analysis, and calculate the results. Not only are these calculations time consuming, but, unless some type of form is provided for easy checking, they are also particularly subject to decimal point errors. With this in mind, a form was devised by which a clerical employe can perform the calculations accurately, using a mechanical calculator to hasten further the operation. This form has the added advantage of clearly specifying each calculation so that deviations from established procedure are impossible. It shortens the training period of new Podbielniak operators through elimination of lengthy calculation instructions.

Fractionation and Methods of Analysis of Fractions

By means of conventional low temperature distillation techniques, gas samples are fractionated into the C_1, C_2, C_3, C_4, C_5 and liquid residue fractions. If a Podbielniak automatic apparatus is used for the fractionation, the results, corrected for column hold-up, are recorded in millimeters of chart travel. If a manual or semi-automatic apparatus is used, the results are recorded in millimeters of pressure. In either case the calculation sheets are applicable, *providing all of the receiver bottles have the same volume*, because the volume of gas in each fraction is being measured fundamentally in terms of the pressure in the receiving bottle.

[1] Technical Manager, Globe Oil & Rfg. Co., Lemont, Ill.
[2] Chief Chemist, Globe Oil & Rfg. Co., Lemont, Ill.
[3] Research Chemist, Globe Oil & Rfg. Co., Lemont, Ill.

DATA SHEET FOR ANALYSIS OF FRACTIONS INTO COMPONENTS

Sample _____ Date Sampled _____

Spot No. _____ Date Analyzed _____

ACID GASES IN TOTAL SAMPLE

(A) Volume of sample (cc's)	84.7
(B) Volume after H_2S removal	84.7
(C) Percentage H_2S = $\frac{(A-B)100}{A}$	0.0
(D) Volume after CO_2 removal	84.7
(E) Percentage CO_2 = $\frac{(B-D)100}{A}$	0.0

C_1 FRACTION

(A) Volume of sample (cc's)	90.0
(B) Volume after O_2 removal	90.0
(W) Percentage O_2 = $\frac{(A-B)100}{A}$	0.0
(C) Volume after CO removal	90.0
(X) Percentage CO = $\frac{(B-C)100}{A}$	0.0
(D) Volume after H_2 removal	90.0
(Y) Percentage H_2 = $\frac{(C-D)100}{A}$	0.0
(E) Volume after CO_2 absorption	0.0
(Z) Percentage CH_4 = $\frac{(D-E)100}{A}$	100.0
Percentage N_2 = $\frac{E(100)}{A}$ or 100 − (W + X + Y + Z)	0.0

C_2 FRACTION

(A) Volume of sample (cc's)	82.3
(B) Volume after O_2 removal	82.3
(C) Volume Air (A−B)5 =	0.0
(D) Volume after C_2H_4 removal	51.5
(E) Percentage Ethylene = $\frac{100(B-D)}{A-C}$ =	37.4

C_3 FRACTION

(A) Volume of sample (cc's)	84.5
(B) Volume after O_2 removal	84.5
(C) Volume air (A−B)5 =	0.0
(D) Volume after C_3H_6 removal	51.5
(E) Percentage Propylene = $\frac{100(B-D)}{A-C}$ =	39.1

C_4 FRACTION

Total Unsaturates

(A) Volume of sample (cc's)	89.0
(B) Volume after O_2 removal	88.5
(C) Volume air (A−B)5 =	2.5
(D) Percentage air = $\frac{C \times 100}{A}$ =	2.8
(E) Volume after C_4H_8 removal	59.0
(F) Percentage C_4 Unsats. = $\frac{100(B-E)}{A-C}$ =	34.1

Isobutylene

(r) Ratio = $\frac{\text{Vol. of bulb } A_1}{\text{Vol. of bulb } A}$ =	1.07
Reference mark	778
Barometric pressure	750
(a) Lower mercury level after evacuation (ave.)	36
(b) Lower mercury level after gas is added to Burette "B"	496
(b_1) Lower mercury level after HCl is added to Burette B_1	528
(f) Lower mercury level after reaction (ave., B & B_1)	480
(h)% isobutylene in total sample = $\frac{100[r(b_1-f)+(b-f)]}{b-a}$ =	14.6
(j)% isobutylene (air free) = $\frac{h \times 100}{100-D}$ (from total unsats.) =	15.0

Butene—1 & Butene—2

Percent Butene—1 and Butene—2 = (F−j) =	19.1

C_5 FRACTION

(A) Total C_5 chart travel incl. air	216
(B) C_5 Chart travel, air free	108
(C) Volume of sample (cc's)	89.8
(D) Volume after C_5H_{10} removal	75.7
Percent Amylenes = $\frac{C-D}{C} \times \frac{A}{B} \times 100$ =	31.4

Figure 2. Sheet No. 2 of operator's form.

The fractions are subsequently analyzed for their individual components by the methods tabulated in Table 1.

Record of Data on Calculation Sheets

The manner in which data is recorded on the calculation sheets can probably be explained to best advantage by reference to the example in Figure 1. Assume that the sample in this example contains neither air nor acid gases. In this case, the chart travel or millimeters pressure corresponding to each fraction is recorded by the operator in the air free column designated S. If there is a liquid residue, the volume of the material is recorded in the appropriate blank on the right side of the sheet. Also to be recorded are the number of the apparatus used for the fractionation and the temperature of the water bath in which the receiving bottles are immersed.

Results of the analyses of the fractions are recorded by the operator as illustrated in Figure 2. Since this form is extremely brief in its titles, some further explanation is probably necessary. The absorbents for the acid gases and those for the constituents of the C_1 fraction are only selective if the analyses are made in the sequence numerically noted in the preceding table. Each analysis in these two instances is made on the residue from the analysis of the preceding constituent.

In transferring samples from the receiving bottles to the Orsat apparatus, air is sometimes drawn into the apparatus, due to some slight leakage. Since this has a dilution effect, it must be corrected for in the calculations. Consequently, provisions are made for results of oxygen determinations and for air corrections on each fraction requiring unsaturate determinations.

In the isobutylene determination, those letters with subscripts refer to the hydrogen chloride section of the apparatus. The reference point is the point to which the upper level of mercury must be brought in each burette after each operation.

It is common practice to add air to the C_5 fraction to prevent liquefaction. This dilution is corrected for in the calculation of the total C_5 unsaturates. The chart travel or mm's pressure recorded in Figure 1 is, of course, for the undiluted C_5 cut.

After the fractions have been analyzed, the results are transcribed by the operator to the sheet illustrated in Figure 1. Since it was previously specified that this was an air-free sample, the results are recorded in the air-free column designated C.

This completes the data with which the clerical employe is provided. Since each operation is defined by the equation at the top of each column, only a partial explanation of the calcula-

TABLE 1
Method of Analysis of Fractions

SAMPLE	Component	Method of Analysis
Original Sample	1. Hydrogen Sulfide	Absorption in acidified cadmium chloride
	2. Carbon Dioxide	Absorption in potassium hydroxide
C_1 Fraction	1. Oxygen	Absorption in potassium pyrogallate or similar commercial preparations
	2. Carbon Monoxide	Absorption in cuprous chloride
	3. Hydrogen	Combustion over copper oxide
	4. Methane	Combustion over copper oxide and absorption of resulting carbon dioxide[1].
	5. Nitrogen	Residue from above analysis of C_1 fraction
C_2 Fraction	Ethylene	Absorption in mercuric-silver nitrate reagent[2]
	Ethane	Residue from ethylene determination
C_3 Fraction	Propylene	Absorption in mercuric-silver nitrate reagent
	Propane	Residue from propylene determination
C_4 Fraction	Total C_4 Unsats.	Absorption in mercuric-silver nitrate reagent
	Isobutylene	Absorption of hydrogen chloride[3]
	Butenes 1 and 2	Difference between total C_4 unsats and isobutylene
	Iso and n-butane	Residue from total C_4 unsat. determination
C_5 Fraction	Total C_5 Unsats.	Absorption in mercuric-silver nitrate reagent
	Iso and n-pentanes	Residue from total C_5 unsat. determination

tions should be necessary.

Calculation of Chart Travel or mm's Pressure Corresponding to Volume of Liquid Residue

For a gas sample of the type under consideration, the chart travel (or mm's pressure) corresponding to the measured volume of liquid residue is calculated by use of the equation shown on the right side of Sheet 1 (Figure 1). The terms in this equation can be best explained by a derivation of the equation, which is as follows:

$$\text{Volume of liquid residue as a gas at 0 C.} = \frac{\text{Volume of liquid residue @ 60 F.} \times \text{sp. gr.}_{60}^{60} \times 22400}{\text{Mole Wt. of liq. residue}}$$

$$= \frac{\text{Volume of liquid residue @ 60 F.}}{\text{Conversion factor}} \quad \text{(A)}$$

where the conversion factor $= \dfrac{\text{Mole Wt. of liq. residue}}{22400 \times \text{sp. gr.}_{60}^{60}}$

The conversion factor represents the volume of a constituent as a liquid at 60 F. which is equivalent to a cubic centimeter of the constituent as a gas at 0 C.

$$\text{Pressure in receiving bottle @ temperature of analysis} = \frac{\text{Volume of gas at 0 C.} \times 760 \times (273 + \text{C})}{\text{Volume of receiver system} \times 273}$$

The volume of the receiving system includes that of the individual receiving bottles and connecting lines up to the shut off valve.

$$\text{Mm's chart travel or mm's pressure in receiving system} = \frac{\text{Volume of gas at 0 C.} \times (273 + \text{C.})}{\text{Pod factor}}$$

where Pod factor $= \dfrac{\text{Volume of receiving system} \times 273}{760}$

The Pod factor includes manometer corrections. For automatic apparatus it includes the factor relating chart travel to pressure.

$$\text{Mm's chart travel or mm's pressure} = \frac{\text{Volume of liquid residue at 60 F.} \times (273 + \text{C.})}{\text{Conversion factor} \times \text{Pod factor}}$$

where Volume of gas at 0 C. $= \dfrac{\text{Volume of liq. res. @ 60 F.}}{\text{Conversion factor (see Equation A)}}$

$$= \frac{\text{Volume of liquid residue at 60 F.} \times (273 + \text{C.})}{0.00582 \times \text{Pod factor}}$$

where 0.00582 is the conversion factor for the hexanes, of which the liquid residue of a gas sample is assumed to be composed.

The result of the liquid residue chart travel or mm's pressure calculation is recorded in column S of Sheet 1.

If the molecular weights, specific gravities with respect to both air and water, cubic feet per barrel, and conversion factors (liquid volume per cubic centimeter of gas) for each constituent are tabulated for quick reference, the calculation time can be reduced considerably.

Calculation for Gas Samples Containing Air

See Figure 4.

When a sample contains air, it is sometimes desirable to calculate the results on an air-free basis. In this case, since the air will be separated with the C_1 fraction, it is necessary to correct the chart travel or mm's pressure and the percentage of the constituents of the C_1 fraction accordingly. Referring to Figure 1, assume that the oxygen, nitrogen, and methane percentages are those shown in the "Includes Air" column.

$$\text{Then the air-free chart travel (or mm's pressure)} = \text{chart travel including air} \times \frac{(100 - \%\ \text{Air})}{100}$$

$$= 864 \times \frac{(100 - 5)}{100} = 821$$

This result is recorded in column S and is subsequently used in arriving at the total chart travel or mm's pressure on an air-free basis.

$$\text{The percentage of each constituent in the } C_1 \text{ fraction} = \frac{\text{percentage of each constituent including air} \times 100}{100 - (\%\ \text{Air})}$$

$$\text{In the example, the percentage methane on the air-free basis} = \frac{95 \times 100}{95} = 100 \text{ percent}$$

This result is recorded in column C.

The balance of the calculations are the same as in the previous example.

Calculations for Samples Containing Acid Gases

In some cases, it is desirable to determine the acid gas content of a sample, such as the dry gas from catalytic cracking units. It is the usual practice to remove these compounds before charging to the fractionating equipment. This makes it necessary to run the acid gas analysis on a separate sample. Consequently the corresponding chart travel or mm's pressure must be calculated. An example of the necessary calculations is shown in Figure 5. Assume that the analysis of the *total* sample showed a hydrogen sulfide content of 6.0 percent and a carbon dioxide content of 4.0 percent. Of the acid gas fraction alone, 60 percent is hydrogen sulfide and 40 percent is carbon dioxide. These figures are recorded in the "include air" column. Oxygen, nitrogen, and carbon monoxide are also present in this type of gas, but it is not customary to make the calculations on an air-free basis. Results are therefore recorded as in Figure 5.

$$\text{Total chart travel including acid gases (or mm's pressure)} = \frac{\text{total excluding acid gases} \times 100}{(100 - \%\ \text{acid gases in total sample})}$$

$$= \frac{1692 \times 100}{(100 - 10)} = 1880$$

Chart travel or mm's pressure due to acid gases = difference in total chart travel (or mm's pressure) figures = 1880 — 1692 = 188.

The balance of the calculations are the same as for the first example.

Calculations for Liquid Samples

The chart travel or mm's pressure corresponding to each fraction and also the percentage of each constituent in a fraction are recorded by the operator in the same manner as described for gas samples. However, Sheet 3 (Figure 3) is used for this purpose. Also to be recorded are the volume and specific gravity of the liquid residue, apparatus number, and the temperature of the water bath. Both the volume and specific gravity should be corrected to 60 F. Space is also provided for an Engler distillation on the sample if this should be of interest.

The gas volume of the various constituents is calculated by use of the equation at the head of column E. This equation was derived as follows:

$$\text{Gas volume of fraction at 0 C. and 760 mm} = V_1 \times \frac{p}{760} \times \frac{273}{273 + \text{C.}}$$

where V_1 = volume of receiving system
p = pressure in receiving bottles due to the fraction
273 + C. = temperature of receiving bottles water bath

$$\text{Gas Vol. of fraction @ 60 F. + 760 mm.} = \frac{\text{Pod factor} \times p}{273 + \text{C.}}$$

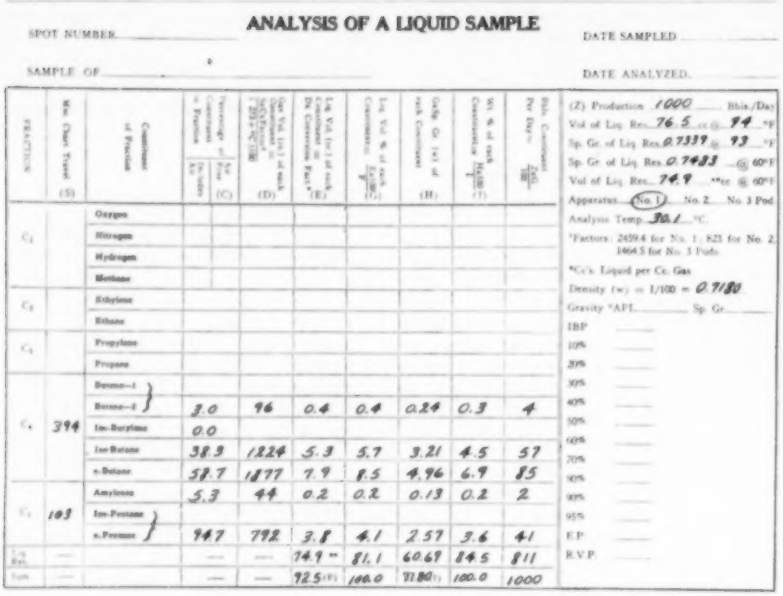
where Pod factor $= V_1 \times \dfrac{273}{760}$ (including manometer correction and chart travel factor.)

$$= \frac{\text{Pod factor} \times \text{S} \times \text{C}}{100\,(273 + \text{C.})}$$

where S × C = pressure (in mm's or in chart travel) in receiving bottle due to constituent.

The liquid volume of each constituent is calculated from the gas volume and the conversion factor. The conversion factor, as was previously explained, is the volume of the constituent as a liquid at 60 F. which is equivalent to a cubic centimeter of the constituent as a gas at 0 C.

$$\text{Conversion factor} = \frac{\text{Mole wt. of the constituent}}{22400 \times \text{sp. gr.}_{60}^{60} \text{ of the constituent}}$$



ANALYSIS OF A LIQUID SAMPLE

SPOT NUMBER _____ DATE SAMPLED _____

SAMPLE OF _____ DATE ANALYZED _____

FRACTION	Mm. Chart Travel (S)	Constituent of Fraction	Percentage of Fraction (C)	Mol. Wt. (sol. of each Constituent in Fraction) (D)	Liq. Vol. (sol. of each Constituent in Fraction Part) (E)	Liq. Vol. % of each Constituent (F)	Sp. Gr. (sol. of each Constituent) (H)	Wt. % of each Constituent (I)	Bbls. Constituent Per Day
C_1		Oxygen							
		Nitrogen							
		Hydrogen							
		Methane							
C_2		Ethylene							
		Ethane							
C_3		Propylene							
		Propane							
C_4	394	Butene—1							
		Butene—2	3.0	96	0.4	0.4	0.24	0.3	4
		Iso-Butylene	0.0						
		Iso-Butane	38.3	1224	5.3	5.7	3.21	4.5	57
		n-Butane	58.7	1877	7.9	8.5	4.96	6.9	85
C_5	103	Amylenes	5.3	44	0.2	0.2	0.13	0.2	2
		Iso-Pentane							
		n-Pentane	94.7	792	3.8	4.1	2.57	3.6	41
C_6 Res.	—		—	—	74.9 **	81.1	6069	84.5	811
Tots	—		—	—	92.5(E)	100.0	71.80(I)	100.0	1000

(Z) Production 1000 Bbls./Day
Vol. of Liq. Res. 76.5 cc @ 74 °F
Sp. Gr. of Liq. Res. 0.7337 @ 73 °F
Sp. Gr. of Liq. Res. 0.7483 @ 60°F
Vol. of Liq. Res. 74.9 **cc @ 60°F
Apparatus (No. 1) No. 2 No. 3 Pod
Analysis Temp. 30.1 °C.
*Factors: 2459.4 for No. 1; 823 for No. 2; 1466.5 for No. 3 Pods
**Cc's. Liquid per Cu. Gas
Density (w) = I/100 = 0.7180
Gravity °API _____ Sp. Gr. _____
IBP _____
10% _____
20% _____
30% _____
40% _____
50% _____
60% _____
70% _____
80% _____
90% _____
95% _____
E.P. _____
R.V.P. _____

Figure 3. Sheet No. 3 of operator's form.

The remainder of the calculations for a liquid sample should be evident from the equations at the top of each column.

Correction for Column Hold-Up

When receivers are changed at the cut point of a fractionation, that portion of the cut between the shut off valve and the thermocouple level in the column remains behind to become part of the next cut. To correct for this error, the volume of this portion of the system should be measured. After the volume is determined, the corresponding chart travel or mm's pressure is calculated, taking into account the effect of pressure and temperature also. The result of this calculation is added to the first cut and subtracted from the second. This correction is repeated for the several cuts of which a sample is composed. Essentially the effect is to increase the amount of the first cut and to reduce the amount of the last. The corrections are applied to the respective cuts by the operator before recording on the calculation sheets.

Correction for Compressibility

Due to deviations from the perfect gas laws, there is a small correction that may be applied for compressibility. At this time the list of the factors to be applied for each individual hydrocarbon is incomplete. Since the correction is so small, it may be neglected for any but the most accurate analyses.

Limitation

All of the receiving bottles and connecting lines of any one apparatus have been made equal in volume. This makes it possible to apply one Pod factor for each instrument. Should the receiving system be composed of bottles of various sizes, the calculations would necessarily be complicated by a different factor for each bottle.

One analysis temperature is used rather than one for each cut. Constant temperature water baths in which the receiving bottles are immersed make it possible to eliminate the disadvantage of temperature fluctuations in the receivers.

Summary

By the use of the illustrated calculation sheets, it has been possible to relieve chemists of the routine task of calculating low temperature distillation analyses of petroleum gases. In addition it has been found that the calculations are made more accurately and rapidly. If Sheet 2 is printed on the back of both Sheets 1 and 3, all of the data and calculations for a sample can be recorded on a single sheet of paper. This simplifies both filing and checking, and it also eliminates the use of scratch papers, which all too often are lost.

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[1] Brooks, Lykken, Milligan, Nebeker, and Zahn—Analytical Chemistry, Vol. 21, Sept., 1949, pp. 1105 ff.
[2] Technical Advisory Committee Analytical Methods, pp. 27-29.
[3] Universal Oil Products Laboratory Test Methods, pp. G 73-78.

Figure 4. Example showing calculations for converting sample to an air-free basis.

Mm. Chart Travel: Includes Air	Mm. Chart Travel: Air Free	Mm. Chart Travel: Includes CO_2 & H_2S	Constituent of Fraction	Percentage of Constituent in Fraction: Includes Air	Percentage of Constituent in Fraction: Air Free (C)
	(S)		Hydrogen Sulfide	0.0	
			Carbon Dioxide	0.0	
			Carbon Monoxide	0.0	0.0
			Oxygen	1.0	
864	821		Nitrogen	4.0	
			Hydrogen	0.0	0.0
			Methane	95.0	100.0
			Ethylene	37.4	
	314		Ethane	62.6	
			Propylene	39.1	
	216		Propane	60.9	
			Butene—1		
			Butene—2	19.2	
	177		iso-Butylene	15.0	
			iso-Butane	65.8	
			n-Butane		
			Amylenes	31.4	
	108		iso-Pentane	68.6	
			n-Pentane		
	13		Liquid Residue	100.0	
	1649	(B)			

Figure 5. Example showing calculations for acid gas content of a sample.

Mm. Chart Travel: Includes Air	Mm. Chart Travel: Air Free	Mm. Chart Travel: Includes CO_2 & H_2S	Constituent of Fraction	Percentage of Constituent in Fraction: Includes Air	Percentage of Constituent in Fraction: Air Free (C)
	(S)		Hydrogen Sulfide	60	
		188	Carbon Dioxide	40	
			Carbon Monoxide	4.0	
			Oxygen	3.5	
864			Nitrogen	35.0	
		864	Hydrogen	18.0	
			Methane	39.5	
	314	314	Ethylene	37.4	
			Ethane	62.6	
	216	216	Propylene	39.1	
			Propane	60.9	
			Butene—1		
			Butene—2	19.2	
	177	177	iso-Butylene	15.0	
			iso-Butane	65.8	
			n-Butane		
			Amylenes	31.4	
	108	108	iso-Pentane	68.6	
			n-Pentane		
	13	13	Liquid Residue	100.0	
	1692	1880			

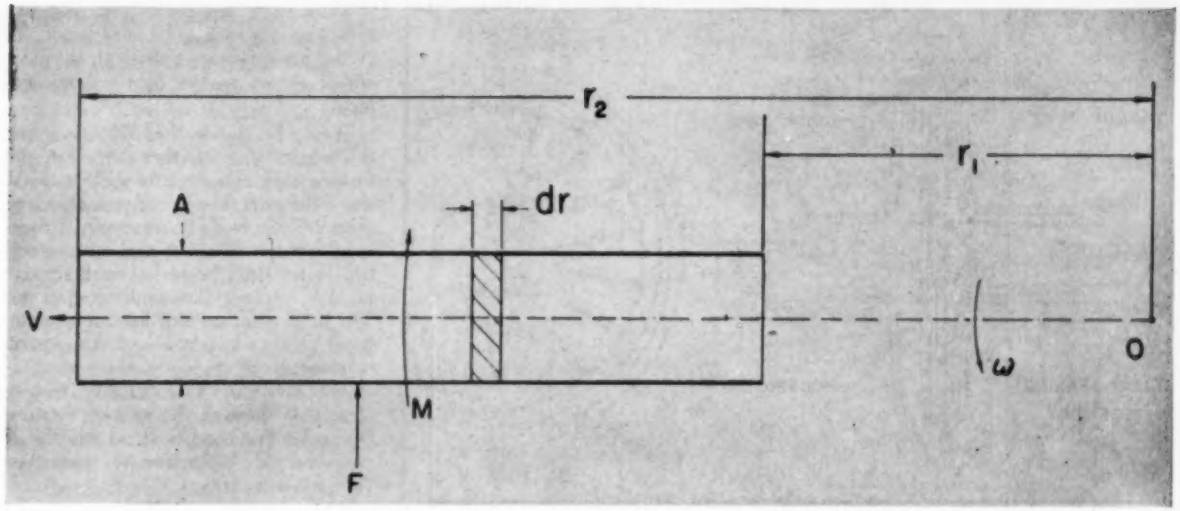

Figure 1. Force and moment produced by Coriolis acceleration.

New Flowmeter Measures True Mass Rate

- **Meter can be calibrated without passing fluid through it**
- **Has high speed of response**
- **Can measure accurate average for pulsating flow**

Y. T. Li and P. A. Lapp, Massachusetts Institute of Technology, Cambridge

THERE IS AN ACUTE demand for an instrument that can measure the actual mass of fluid that is carried past it per unit time. Almost all commonly used flowmeters are designed to measure the volumetric flow of fluids. When mass flow is required, it is necessary to know the fluid density, variations of which can cause extreme difficulty. A knowledge of mass flow is vital in many applications.

When the flow-rate changes rapidly with time, it is sometimes important to know the instantaneous flow-rate. A flowmeter with insufficient speed of response will produce large dynamic errors. Applications in jet and rocket engine research, as well as in the petroleum industry, are increasing the demand for flowmeters with fast response speeds.

This article describes a new type of meter that measures mass flow-rate directly and accurately. The meter possesses a high speed of response, and is capable of measuring instantaneous flow-rates at frequencies up to several hundred cycles per second. In addition, its output varies linearly with flow-rate, thus making possible the measurement of the average flow under pulsating conditions.

Currently Available Flowmeters

The constant-area, variable-head class of flowmeters, often called headmeters, are perhaps most widely used. The orifice, venturi and flow-nozzle meters belong to this class. This type of flowmeter measures the pressure drop across a fixed restriction in the flow path. The inherent nonlinearity between flow-rate and pressure drop seriously restricts the usable range of operation, and causes acute difficulties in measuring rapidly varying flows.

The inherent nonlinearity of the headmeter is overcome in another class of flowmeters which maintain the pressure drop constant across a variable restriction in the flow path. The area of the restriction is a linear function of the volumetric flow-rate.

The output of both these types of flowmeters is highly dependent on the viscosity, temperature and compressibility of the fluid. Also, the fluid density must be known if mass flow is required.

More elaborate volumetric flowmeters measure the speed of a flow-actuated turbine or positive displacement motor. Again, the fluid density is required to obtain mass flow.

One type of mass-rate flowmeter has been designed which utilizes the Magnus principle: Two passages are formed in the fluid stream by introducing a cylinder in the middle of the stream, rotating at constant speed about an axis perpendicular to the flow direction. The flow is thus divided into two equal passages formed between the cylinder and wall of the instrument chamber. It can be shown, assuming several ideal conditions, that the pressure difference between these two flow passages is a linear measure of mass flow.[5] Unfortunately, actual operating conditions deviate considerably from the ideal assumptions, so that the meter requires careful calibration and knowledge of certain properties of the fluid.

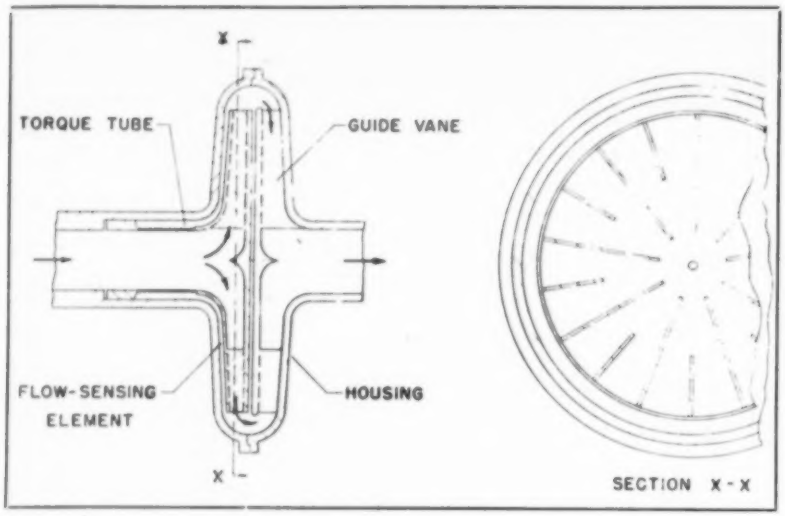

Figure 2. Impeller-type mass rate flowmeter.

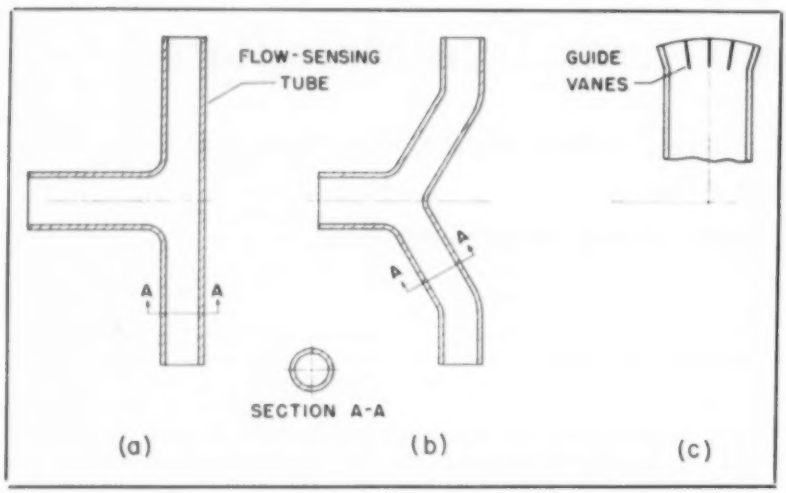

Figure 3. Flow-sensing elements: (a) T tube, (b) Y tube, (c) guide vanes.

Consequently, currently available flowmeters leave much to be desired if mass flow is to be measured efficiently, with sufficient speed of response.

Principle of Operation

The true-mass-rate flowmeter measures the moment required to apply a Coriolis acceleration to the fluid stream. As in Figure 1, the fluid is assumed to flow uniformly through a straight rotating tube; each fluid particle moves parallel to the others and rotates at a constant angular velocity w about an axis through O, intersecting the tube axis at right angles. The fluid moves with a velocity V, and is subject to a uniform Coriolis acceleration given by:

$$a = 2Vw \qquad (1)$$

The total force acting on the wall of the tube, in a direction perpendicular to its axis, between the radii r_1 and r_2 is:

$$F = \int_{r_1}^{r_2} 2Vw\rho A\, dr$$
$$= 2VA\rho(r_2 - r_1)w \qquad (2)$$
$$= 2w(r_2 - r_1)W$$

where

ρ = Fluid density
A = Cross-sectional area of tube
W = Mass flow-rate

The net moment acting on the tube about O produced by the moving fluid is:

$$M = \int_{r_1}^{r_2} 2Vw\rho Ar\, dr$$
$$= VA\rho(r_2^2 - r_1^2)w$$
$$= w(r_2^2 - r_1^2)W \qquad (3)$$

Thus both the force and moment acting on the tube are linear functions of the mass flow-rate through the tube which serves as the flow-sensing element.

It can be shown that Equation (3) is independent of the shape of the flow-sensing element and the nature of the fluid and flow pattern within the element.[5] It is only necessary to ensure that the entrance and exit velocities of the fluid be radial with respect to the rotating flow-sensing element. The fluid entering and leaving the element will then have no tangential component of velocity, i.e., the entrance and exit flow velocity vectors both pass through the axis of rotation O. Under this condition, no additional moment will exist due to tangential velocity components.

One practical arrangement utilizing this principle consists of an impeller connected by a torque tube to a housing, as shown in Figure 2. The housing is rotated at constant speed (gearing and motor not shown) and is connected to the stationary flow passage at both ends by suitable rotary seals.[4] Attached to the impeller are guide vanes which provide radial inlet and outlet fluid velocities. The Coriolis moment is transmitted by the impeller guide vanes to the torque tube which elastically deflects with respect to the housing. The elastic deflection of the torque tube, which may be measured with a wire strain-gauge or similar device, is a linear measure of the Coriolis moment, and hence the mass flow-rate.

The torque required to rotate the fluid is recovered in the impeller guide vanes, so that the driving motor need supply only the torque necessary to overcome bearing and seal friction and windage. The output signal is independent of this frictional torque. This device can be used bi-directionally since reversed torque results from reversed flow. The scale factor is determined by the motor speed.

Several experimental models have been constructed and tested with excellent results. One is described later in this article.

The Flow-Sensing Element

The flow-sensing element must impart a known velocity change to the fluid, by diverting it in a radial direction from the axis of rotation. It must also possess a small polar moment of inertia about the axis of rotation, be compact and simple in construction, and produce a minimum of pressure drop in the fluid stream.

The impeller-type just described possesses a rather large polar moment of inertia. A simple T tube, shown in Figure 3a, has a comparatively smaller

polar moment of inertia, simple construction, and is more compact. The pressure drop associated with the sharp bends can be reduced by using a Y tube, shown in Figure 3b. Guide vanes, as shown in Figure 3c, should be used if there is danger of tangential fluid velocity with respect to the flow-sensing element; this particularly applies in the case of short, wide tubes. Since r_1 is usually much smaller than r_2, guide vanes are normally used only for the outlet flow. An error of 10° in the exit angle, from purely radial flow, produces only a 2 to 3 percent flow measurement error for the model herein described.

The speed of response of the flowmeter varies directly as the natural frequency of the flow-sensing element. For the T tube of Figure 3a, the natural frequency can be shown to be:[5]

$$f_n = \frac{1}{2\pi} \cdot \frac{3}{2} \cdot \sqrt{\frac{Vwr_m}{d_{max} r_2 \left(1 + \frac{\rho_t A_t}{\rho A}\right)}} \quad (4)$$

Where:

V = Fluid velocity
w = Angular velocity of the flow-sensing element
r_m = Radius at which the force-sensing element is attached to the flow-sensing element
d_{max} = Maximum deflection of the force-sensing element
r_2 = Exit radius of the flow-sensing element
$\rho_t A_t$ = Mass per unit length of the tube wall
ρA = Mass per unit length of the fluid

Consequently, for a high speed of response, the angular and flow velocities should be high, and the deflection of the force-sensing element should be as small as possible. The latter requirement is best fulfilled using mechano-electric transducers, where d_{max} need never exceed 0.001 inch.

The natural frequency of the flowmeter to be described is approximately 600 cps.

Description of Experimental Model

The model herein described was constructed to test the theory and supply information for future designs. It has a five-inch diameter rotor, rotating at 1800 rpm, with a flow capacity of 5 to 10 gpm of water. The flowmeter is shown in Figures 4 and 5.

The flow-sensing element consists of a T tube enclosed in a heavy, rectangular housing, similar to a sector of the impeller-type previously described. The rotary seals and shaft bearings are precision-bored cast-iron bushings with just sufficient clearance to permit ease in rotation.

The construction of the force-sensing element is shown in Figure 6. The strains in the flow-sensing tube are transmitted by a rocker arm to unbonded strain-gage wires, which are mounted in a container external to the fluid being metered. The insulator pins are rigidly connected to the housing so that the strain-gage wires measure the relative deflections of the flow-sensing tube. A small flexible diaphragm supports the rocker arm to which damping vanes are attached. The complete strain-measuring capsule is filled with a viscous fluid which provides damping, protection of the strain-gage wires from corrosion, and aids in dissipating heat generated by the measuring current.

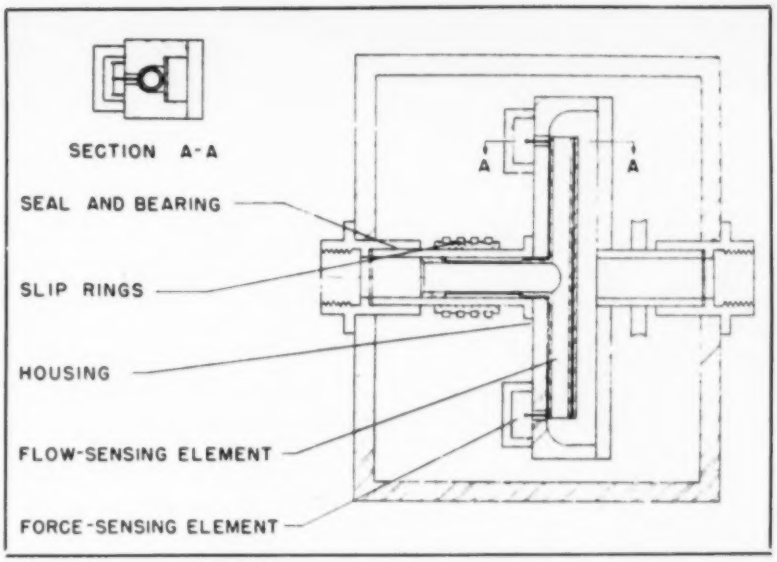

Figure 4. Schematic section of model flowmeter.

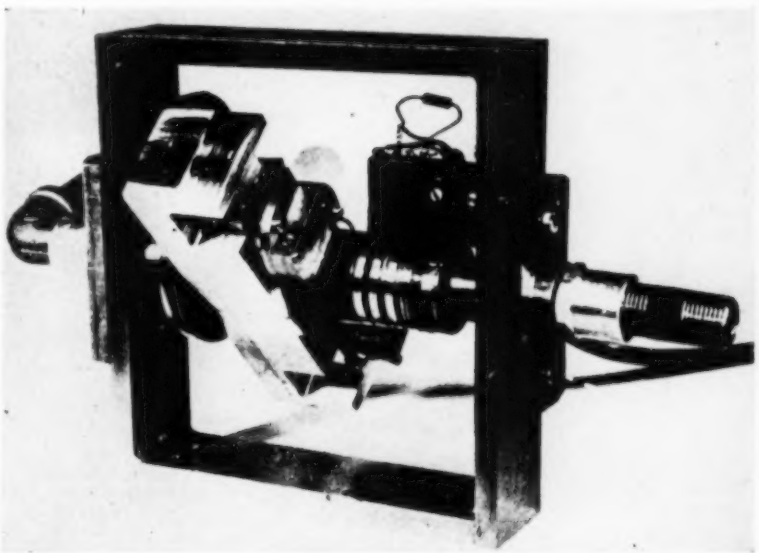

Figure 5. The new flowmeter.

Two such strain-measuring capsules are mounted symmetrically on the flow-sensing element. The electrical and mechanical symmetry of the instrument make the strain-gage bridge quite insensitive to internal pressure changes. The meter is stable, compact and rugged; tests have shown that the output is almost unaffected by pressure and temperature variations.

Flowmeter Performance

Static Performance: The static sensitivity of the flowmeter depends on two factors: The relation between generated torque and mass flow, and the relation between electrical output and generated torque. The former depends on the geometry and rotational

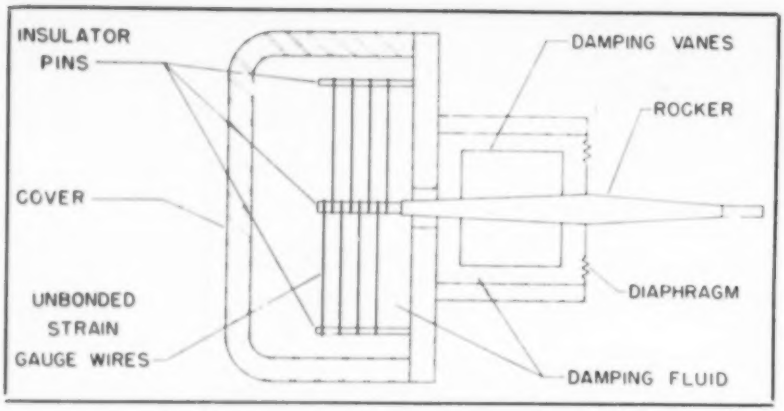

Figure 6. Force-sensing element used on model flowmeter.

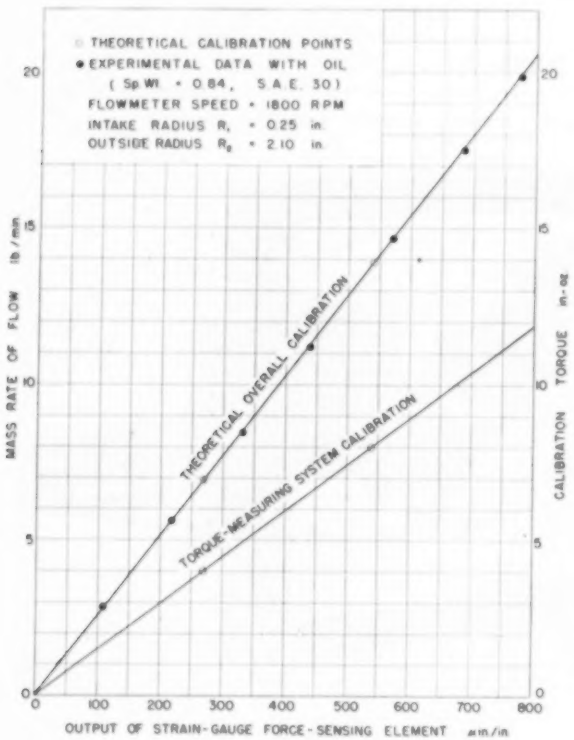

Figure 7. Flowmeter calibrations for steady-flow conditions.

speed, and should be constant for any particular meter. The latter can be measured using an artificially produced torque. The meter can thus be calibrated without passing a known fluid through it.

Theoretical and experimental static calibrations are presented in Figure 7, which verify that the meter output increases linearly with mass flow. Other tests have proved that this calibration is independent of fluid density and viscosity. The instrument could be used equally well with gases; however, this particular model was designed for liquid flow.

Dynamic Performance: The dynamic performance of the flowmeter was tested by attempting to apply a sudden rise in mass flow. The results indicated a close agreement with the predicted natural frequency of 600 cps. The meter was also tested with flows in which strong pulsations were superimposed on a steady component. Under these conditions, it is usually desired to measure only the true average flow.[3] The average value of the meter output, in this circumstance, indicated less than 2 percent error for flows with large-amplitude pulsations, using frequencies as high as 100 cps.

Current Development

Mass-rate flowmeters, for use in high pressure applications, must transmit the Coriolis force, generated inside the flow-sensing element, to an external transducer. A force-transmitting device has been developed which serves to separate the signal element from direct contact with the fluid, and transmits the small Coriolis force independently of fluid pressure.

This device makes possible a mass-rate flowmeter capable of measuring fluid at 3000 psi over a temperature range from —65 to 250 F., with a natural frequency of 600 cps. Another flowmeter is being designed to measure the flow of a steam and coal powder mixture, in a one-to-one ratio, in an eight-inch diameter pipe, at a rate of 30,000 pounds per hour.

Development is also being directed toward the design of improved rotary seals to withstand higher pressures with lower friction.

Conclusions

The flowmeter described in this article is capable of measuring the true-mass flow linearly and independent of pressure, viscosity, density and temperature. The fluid may be inhomogeneous; multi-phase fluids or mixtures of liquids and solids may be measured with equal ease. The meter is bi-directional and may operate over a wide range of flow-rates due to its linearity. Calibration may be made without passing known flows through the meter, and this calibration is valid for any fluid that is capable of passing through the instrument. The scale factor is easily shifted over a wide range by changing the rotational speed. The meter introduces only a small pressure drop in the fluid stream, has a very high speed of response and is capable of indicating an accurate average for pulsating flows.

The output of the flowmeter is electrical in form at present, but could be a pneumatic or mechanical signal with some loss in speed of response.

The mass-rate flowmeter thus answers the demand for an instrument capable of measuring true-mass flow. Future development in the design and use of this instrument is predicted to cover even broader ranges of application than are herein presented.

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3 "The Mass Flow Meter, A Method for Measuring Pulsating Flow," by D. Brand and L. A. Ginsel, Instruments, **24**, p. 331, 1951. "A Flowmeter Designed to Measure Mass Flow by Direct Calibration," by S. M. Tennant and J. R. Turner, M.S. Thesis in Mechanical Engineering, Massachusetts Institute of Technology, 1950.

4 "Mechanical Seals," by D. R. Lewis, Machine Design, **18**, p. 125, 1946. "Sealing a Rotary Shaft Metal Bellows Construction," by R. Hammond, Chemical Age (London), **55**, p. 199, 1946. "Hydraulic Seals," by F. Flick, Machine Design, **20**, p. 139, 1948.

5 "A Fast-Response True-Mass-Rate Flowmeter," by Y. T. Li and S. Y. Lee, ASME, Trans., July, 1953.

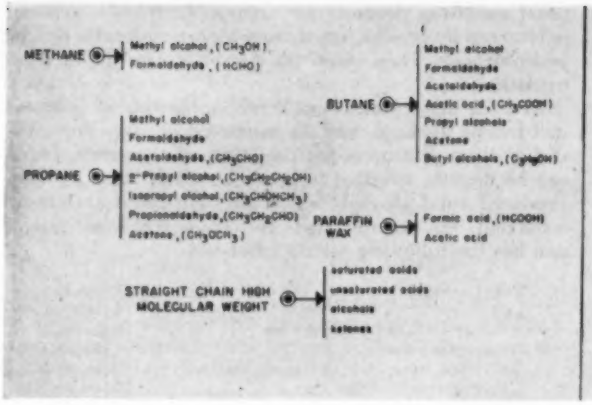


Table 1. Oxidation of paraffin hydrocarbons. Principal oxygenated products.

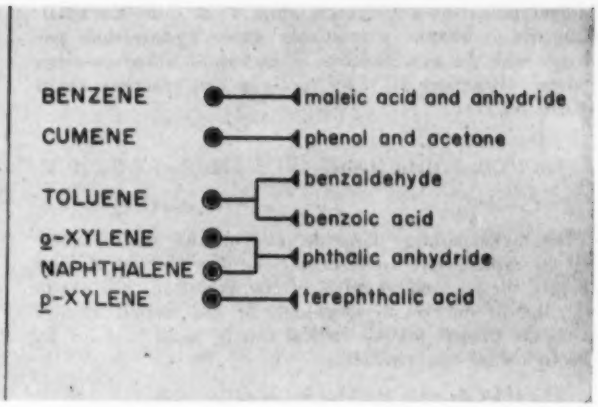


Table 2. Oxidation of aromatic hydrocarbons from petroleum.

Understanding the Chemistry of

. . . Petrochemical Reactions

III. Non-Hydrocarbon constituents of petroleum oxygen compounds

IV. Oxidation of Hydrocarbons

V. Chlorination of paraffin and aromatic hydrocarbons

Lewis F. Hatch, University of Texas
Austin

THERE ARE relatively few reactions which may be used commercially for the utilization of hydrocarbons and this is especially true of the paraffins and naphthenes. The aromatic hydrocarbons are both more reactive and amenable to more different types of reactions, while the olefins and acetylenes are in a class by themselves and will be discussed at length in subsequent articles.

The "big six" of reactions in respect to commercial application with hydrocarbons, other than olefins and acetylenes, are cracking, dehydrogenation, oxidation, chlorination, nitration and, with aromatic hydrocarbons, sulfonation. Only the last four types of reactions will be discussed because they produce, directly, end-use chemicals for the chemical industry.

The most promising of these reactions is the direct production of organic oxygenated compounds (alcohols, aldehydes, ketones, acids and acid anhydrides) by oxidation of paraffinic, naphthenic and aromatic hydrocarbons. This coverage omits for the present the important recent developments in the field of partial oxidation of paraffins to produce synthesis gas ($CO + H_2$) and acetylene.

The oxidation of paraffin hydrocarbons can be carried out in either the vapor phase or liquid phase (for the higher molecular weight ones), using either oxygen or air. The vapor phase oxidation of liquefied petroleum gases (LPG) presents three rather serious technical problems. The first problem is to operate outside of the explosive limits of the hydrocarbon-air mixture. This is done by using a large excess, either of the hydrocarbon or of air. If an excess of air is used, the problem of recovering the more volatile oxidation products (e.g. formaldehyde and acetaldehyde) becomes serious. When an excess of hydrocarbon is used, the conversion is low with the problems of the recovery of products and the recycle of hydrocarbon a limiting factor.

The second problem is as old as organic chemistry—the multiplicity of products one may get from seemingly simple reactions. The oxidation of paraffin hydrocarbons is especially fruitful in respect to different products (Table 1), all of which must be separated and then marketed in the same ratio in which they are produced. Fortunately, all of the oxidation products of the lower molecular weight hydrocarbans have long been established in the chemical field.

The third drawback to oxidation is the loss of hydrocarbon in the form of carbon monoxide and carbon dioxide.

• **Several reaction theories** have been advanced to account for the various compounds formed during air oxidation of hydrocarbons. The current reaction mechanism proposes the initial formation of a free hydrocarbon radical (Reaction I) which in turn reacts with an oxygen molecule to form a hydrocarbon peroxide radical (Reaction II).

I. $CH_3CH_2CH_3 + O_2\,(air) \rightarrow CH_3\overset{*}{C}HCH_3 + HO_2^*$

II. $CH_3\overset{*}{C}HCH_3 + O_2 \rightarrow CH_3CH(O{-}O^*)CH_3$

There is still some disagreement as to what happens next. Most experts believe that the hydrocarbon peroxy

radical picks up a hydrogen atom from a hydrocarbon molecule to become a relatively stable hydrocarbon peroxide with the simultaneous formation of a hydrocarbon radical (Reaction III) to continue the reaction chain (Reaction II).

III.

$$CH_3CHCH_3 + CH_3CH_2CH_3 \rightarrow CH_3CHCH_3 + CH_3\dot{C}HCH_3$$
$$\quad O{-}O^* \qquad\qquad\qquad\quad O{-}O{-}H$$

The hydrocarbon peroxide and/or the hydrocarbon peroxy radical may break in any one of a number of ways to give the various products of the oxidation. For example, the production of acetaldehyde and methyl alcohol from the propyl peroxy radical can be accounted for by the following two reactions.

$$CH_3CH(O{-}O^*)CH_3 \rightarrow CH_3CHO + CH_3O^*$$

$$CH_3CH_2CH_2 + CH_3O^* \rightarrow CH_3\dot{C}HCH_3 + CH_3OH$$

The formation of the propyl radical permits the reaction to continue by way of Reaction II. The decomposition of the hydrocarbon peroxide would have produced the aldehyde and alcohol directly with the chain continuing step being the formation of the peroxide (Reaction III).

$$CH_3CH(O{-}O{-}H)CH_3 \rightarrow CH_3CHO + CH_3OH$$

The temperature at which the oxidation takes place determines the nature of the products. With propane, the onset of reaction is about 250 C. with the production of the maximum amount of the desired oxygenated products. At a temperature of about 500 C., the principal products are propylene and hydrogen peroxide radical.

$$CH_3CHCH_3 \rightarrow CH_3CH=CH_2 + HO_2^*$$
$$\quad O{-}O^*$$

Higher temperatures give mainly ethylene and methane; above 800 C., the principal products are acetylene, carbon and hydrogen. An increase in pressure changes the nature of the products at a given temperature or permits the obtaining of the same products at a higher temperature. Pressure also increases the rate of reaction, thus shortening the residence time in the reactor.

There appears to be no heterogeneous catalysts which are valuable in producing a specific compound. The use of hydrogen bromide (HBr) as a homogeneous catalyst (Shell Chemical Company) is reported to give up to a 66 percent yield of acetone from propane at 150° C., using oxygen.

• Oxidation processes make up a big business. Both propane and butane are commercially oxidized by Celanese Corporation of America. The hydrocarbons are separately oxidized by air at 350 to 400 C., under a pressure of 100 psig with a 10 percent conversion per pass. The various products of these oxidations are given in Table 1. Propane does not yield acetic acid directly, but it is reported that acetic acid is obtained directly by the oxidation of butane at the Pampas, Texas, plant of Celanese. The pioneering work of Celanese in the field of hydrocarbon oxidation was undertaken with the object of obtaining acetic acid to use in the production of cellulose acetate (Celanese). The bulk of the acetic acid production still comes from the oxidation of acetaldehyde.

Cities Service Oil Company uses natural gas as its raw material for oxidation in a one pass process which oxidizes all of the hydrocarbons present except methane. The usual oxidation products are separated, and the methane is returned to the line, freed from higher molecular weight hydrocarbons. They claim the use of a catalyst in their oxidation.

In 1952 there were about 2 million barrels of propane and butane oxidized, and the estimated quantity for 1953 is 3 million. Butane is the preferred raw material, for it can be directly oxidized to acetic acid and there are also produced butyl alcohols which are high profit chemicals. *n*-butanol, for example, sells for about $0.13 per pound and has the following use distribution:

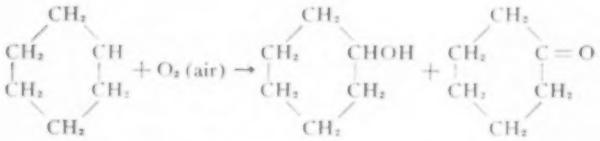
Butyl acetate	35 percent
Lacquers	16 percent
Dibutyl phthalate (a plasticiser)	10 percent
Other plasticisers	4 percent
Butylated urea and melamine resins	10 percent
Other chemical uses	16 percent
Miscellaneous uses	9 percent

At present Carbide and Carbon Chemicals Company, and Tennessee Eastman are the chief producers of synthetic *n*-butanol. Acetaldehyde is their starting material.

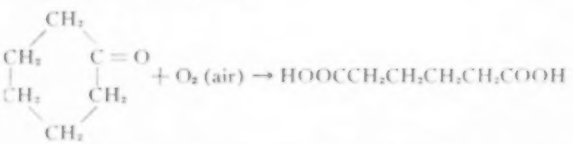
The competitive position of the oxidation of paraffin hydrocarbons lies in its ability to produce oxygenated compounds directly while processes involving olefins usually require two or more separate steps. Oxidation will also produce oxygenated compounds not obtainable from olefins (e.g. propionaldehyde, *n*-propyl alcohol, *n*-butanol).

• The liquid phase oxidation of paraffin wax is of industrial importance, though not potentially as valuable as the oxidation of LPG. The oxidation is catalytically carried out using air at relatively low temperatures (100-150 C.) and under pressures up to 20 atms. The products (Table 1) are not as varied as might be expected, the main ones being high molecular weight acids which are used to make soaps. If alcohols are desired, weak acids are added to esterify the alcohols as formed, thus inhibiting their further oxidation.

Cyclohexane is the only naphthene of importance which is commercially oxidized. The oxidation is a two-step process with the first step being a liquid phase air oxidation using a cobalt acetate catalyst to give a mixture of cyclohexanol and cyclohexanone (KA).



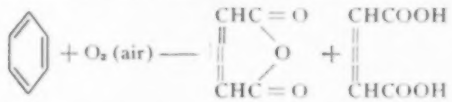
For further air oxidation, it is necessary to separate the alcohol from the ketone and oxidize it separately to the ketone. The combined ketones are then oxidized in the vapor phase to adepic acid.



Nitric acid oxidation is also used and has the advantage of direct oxidation of the alcohol-ketone mixture to adepic acid. The stable cyclohexyl peroxide intermediate from the initial air oxidation of cyclohexane may be separated and directly oxidized to adepic acid by nitric acid. Adepic acid is used in the production of nylon.

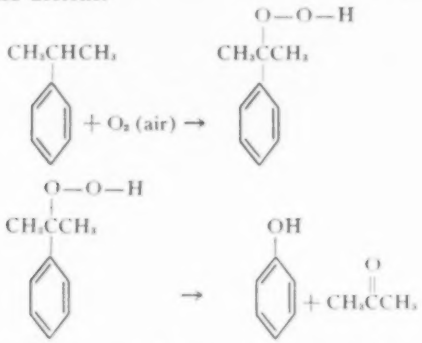
• The oxidation of aromatic hydrocarbons differs

materially from that of paraffin hydrocarbons. The oxidation is usually carried out at higher temperatures and in the presence of a catalyst. Another important difference is that usually only one organic compound is produced. Benzene, for example, is oxidized at 400 to 450 C. over a vanadium pentoxide catalyst to give a 50 to 60 percent yield of maleic anhydride and maleic acid.



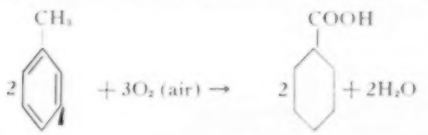
This is an exothermal reaction and maintains itself when once started. Atmospheric pressure is used and a contact time of 0.1 seconds. Both maleic acid and maleic anhydride are used in the manufacture of plastics.

The oxidation of cumene is similar to the oxidation of a paraffin hydrocarbon because of the formation of cumene peroxide. The peroxide is catalytically split to phenol and acetone.

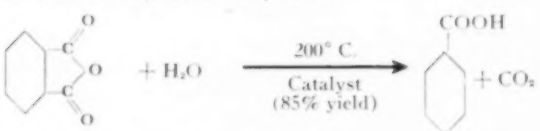


The oxidation of cumene is becoming an important method for the production of phenol. The cumene is obtained by the alkylation of benzene with propylene. This same oxidation cleavage process is being used by Hercules Powder and Distillers Company, Ltd., for the production of p-cresol, resorcinol, hydroquinone and other phenols.

The oxidation of toluene would appear to offer an attractive method for the preparation of benzoic acid.



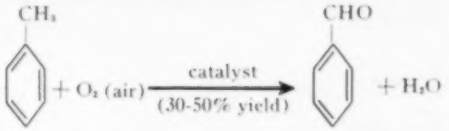
The oxidation of a side-chain on a benzene ring is a standard method for the production of compounds with a carboxyl group (—COOH) attached to the ring. In this case, however, benzoic acid is actually obtained by the decarboxylation of phthalic anhydride.



Benzoic acid is used in the preparation of dyestuffs, pharmaceuticals, resins, perfume bases, toilet preparations, etc. Its sodium salt is that which is present in foods as a preservative in amounts "not more than 1/10 of one percent."

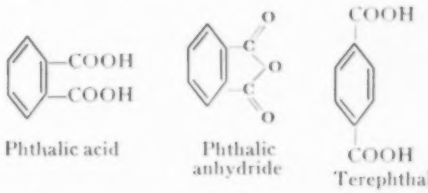
Benzoic acid formerly was made by the hydrolysis of benzotrichloride; but this process is at a competitive disadvantage, because the final product is usually contaminated by chlorine containing compounds which make it unsuitable for use in perfumery.

Benzaldehyde is prepared by either liquid phase exidation (using manganese dioxide and sulfuric acid) or catalytic vapor phase oxidation of toluene.

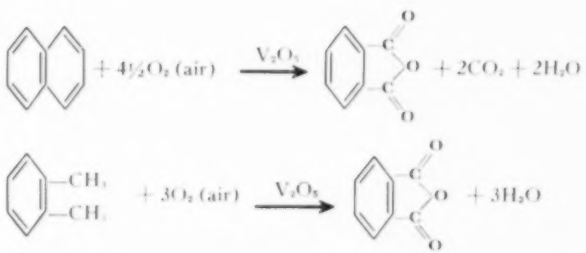


The former method is the more costly but yields a purer product (less benzoic acid) and is readily adaptable to small scale manufacture. A recent competitive method is the condensation of carbon monoxide and benzene under pressure. Benzaldehyde is used in the preparation of dyes, flavors, foods, drugs, cosmetics, pharmaceuticals and miticides.

The oxidation of dialkylated benzene leads to the formation of two carboxyl groups attached to the benzene ring. Two of these dicarboxylic acids are of considerable importance: phthalic acid (and its anhydride) and terephthalic acid.



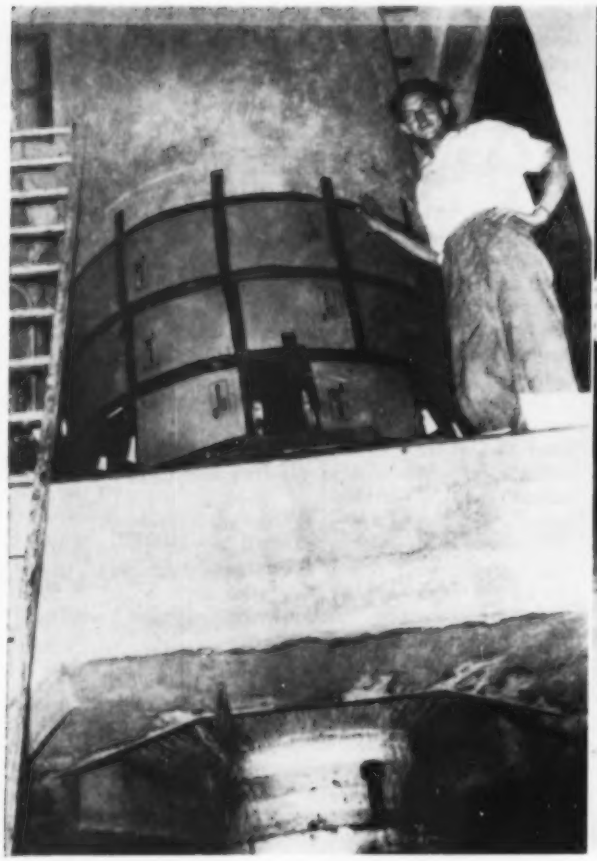
Phthalic acid is of limited importance, but its anhydride, phthalic anhydride, is one of the fundamental raw materials in the production of alkyd resins and of plasticizers for vinyl and nitrocellulose resins. Phthalic anhydride is produced by the direct oxidation of naphthalene and *ortho*-xylene.



Both of these raw materials are obtainable from petroleum, but at present naphthalene, from which 90 percent of the phthalic anhydride is produced, comes almost entirely from coal tar. The *o*-xylene is derived almost wholly from petroleum.

Terephthalic acid is urgently needed as a raw material for the production of dacron and terylene textile fibers. The only compound of importance for its synthesis is *para*-xylene. The outstanding producer of *p*-xylene is Standard Oil Company of California. It erected the first commercial plant for the separation of *p*-xylene from petroleum raw materials at its Richmond, Calif., refinery early in 1950. They are building their second plant at El Segundo refinery. Humble Oil & Refining Co. and two other producers are erecting plants or have them in the planning stage.

The very important recent developments in the technology of the production of the phthalic acids, along with economic considerations, has been the subject of two excellent papers by Peter W. Sherwood in the March and April, 1953, issue of the Petroleum Refiner.



1 Cataloged and ready for exposure, the film holders are placed on the outside of the reactor.

2 Next, catalog numbers on the film are checked before processing. The film is developed in the mobile lab in the background.

Reactor Inspected By Isotopes

THE LARGEST single industrial collection of radioactive isotopes in the United States—76,000 millicuries of Iridium 192—was used to inspect a reactor at the Eastern States Petroleum Company refinery in Houston. It was also the first time that isotopes were used to look for hydrogen blisters in the steel of a refinery reactor unit. The Iridium 192 charge was in the form of five capsules each only $\frac{1}{2}$ inch in length.

The reactor under inspection was 20 feet high and $5\frac{1}{2}$ feet in diameter. The walls were $2\frac{3}{8}$-inch steel plus five inches of concrete and a $\frac{1}{8}$-inch-thick chrome steel liner. The job was accomplished in a single shot and took 8 hours.

Film Carefully Oriented

First, the crew taped film sheets all around the steel tank. Each film was carefully oriented and cataloged as to its exact position on the tank. Then the Iridium 192 charge was loaded into a special camera and lowered on a steel cable into the reactor. After exposure, the films were removed and developed. Each film was interpreted by an expert.

Protective Devices Essential

Each man working on the project was protected by a docimeter—a device which measures the amount of radiation to which a man has been exposed. The isotopes are handled in lead "castles" which shield handlers from the radioactive rays.

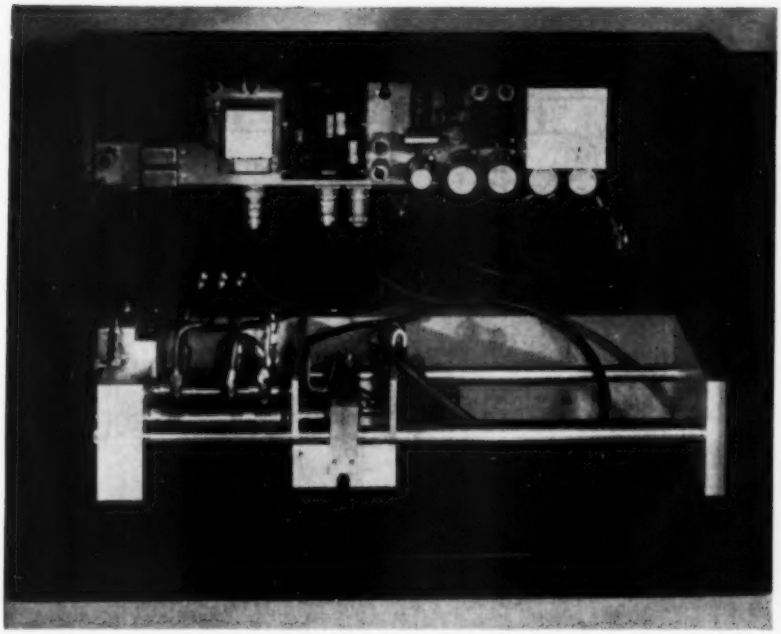


Figure 1. Infrared gas analyzer—internal view.

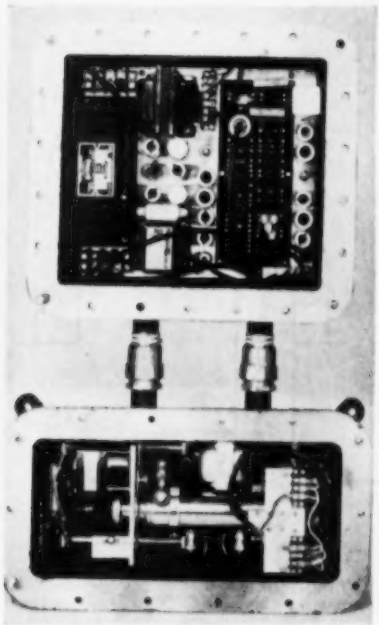


Figure 2. Infrared gas analyzer, single beam type, in explosion-proof housing.

Electrical problems in

Petrochemical Process Control

These are valuable tips on frequency response techniques, explosion-proofing, maintenance and fast-acting control.

D. J. Pompeo, Shell Development Company, Emeryville, Calif.

AMONG THE requirements for the economical production of top quality product is the precise control of process variables. While the control of such variables as temperature, pressure, level and flow is sufficient in certain operations this is not the case in modern large scale processes. Thus new types of control instruments are entering the field. These instruments continuously analyze for a particular component or impurity in a plant stream or continuously measure a physical property which is an index of the quality of the product.

The new process controls are justified from the standpoint of better plant operation because (1) periodic checks in the control laboratory which introduce delays in the measurement of product quality are eliminated and (2) continuous analyses made on the spot enable immediate corrective action to be applied to the process to maintain product quality.

Operations may be based on measurements either in liquids or gases of dielectric properties, paramagnetism, refractive index, light absorption (in ultraviolet visible or infrared), x-ray absorption and viscosity, depending on the physical property best suited for the analysis required. Most of these instruments are basically electrical and/or electronically operated and permit connecting quality criteria back into the control system.

As examples of quality control, the blending of a fuel oil with cutter stock in one of the California refineries is being accurately controlled by a measurement of viscosity. Use of this equipment effects considerable savings in cutter stock by closer control of the blending operation. A chemical plant uses dielectric constant measurement for continuously measuring the water content of product acetone as it comes from a distillation column to produce a specification grade material and infrared gas anal-

Original presentation was at the AIEE Pacific General Meeting, Phoenix, Ariz., August 19-23, 1952.

MAINTENANCE / OPERATION

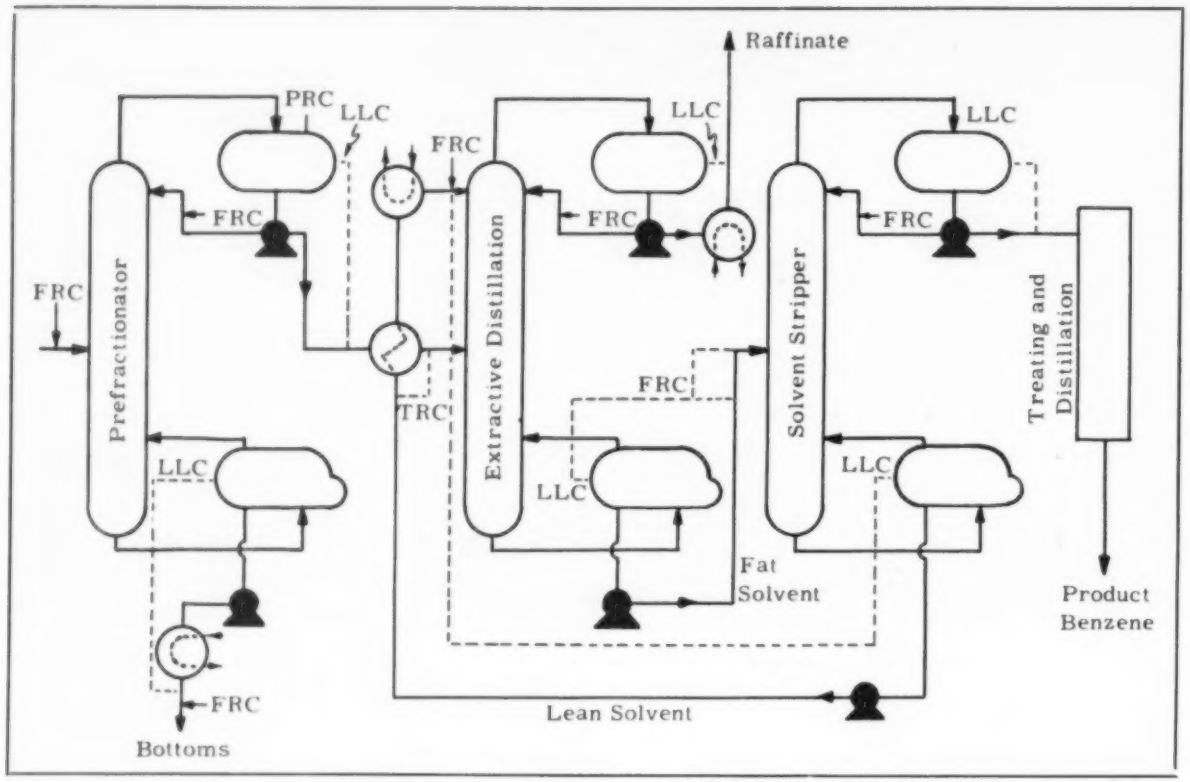


Figure 3. Instrumentation used on a petrochemical process for recovery of pure benzene.

ysis for continuous measurement of the propylene content of a feed stock for manufacture of isopropyl alcohol.

Explosion Proofing

The increasing use of electrical type of process control equipment in refineries and chemical plants bring to the fore problems connected with (a) the design of explosion proof equipment for use in hazardous atmospheres and (b) the design of equipment for ease of maintenance.

Two methods are in use for minimizing the hazards connected with the installation of electrical equipment in explosive atmospheres; one method is to place equipment in an air tight box pressurized with a few ounces of air or inert gas to prevent the space being filled with an explosive mixture. Pressure cutout devices are installed to inactivate the equipment when repairs are necessary. The other method which is well established for switch gear and related equipment is to install electronic components in explosion proof boxes which meet underwriters specifications for Class 1, Group D equipment. Because of the heat evolved by transformers, vacuum tubes and resistors the placing of components in an explosion proof box increases difficulties of heat dissipation with attendant problems of circuit instability. Hence it follows that components such as resistors and condensers must be of high quality to impart stability requirements for such application. The development of transistors[1] which are compact, rugged, need no warm-up, require little power and have no filament to burn out may well be one answer to the difficulties of heat dissipation. However, this will require redesign of circuits to replace certain of the vacuum tube components. Since transistors do not heat up like vacuum tubes, equipment can be constructed more compactly requiring less air space for heat dissipation.

Figure 1 shows a photograph of an infrared gas analyzer of the first type having a pressurized cabinet holding electrical components, and for comparison Figure 2 shows a similar infrared instrument completely enclosed in an explosion proof box with cover removed.

Maintenance

One of the important factors in the application of process control equipment whether this be of the penumatic or electrical type is the question of maintenance. It may well be that high repair and maintenance costs would materially reduce economic justification for continued use of control equipment. Efforts are therefore made by design engineers of both instrument companies and of industrial research organizations to produce equipment having long life and to make possible quick and easy repair. Trends seem to be in the use of packaged units which can be easily removed for repair at a suitable time and replaced with new units taken from stock. This minimizes the time processes are off automatic control.

Further, the maintenance of new type of electrical process control instruments require specially trained personnel to properly handle repair of the equipment. The use of recording colorimeters, recording refractometers and recording infrared analyzers, requires that instrument repairmen have a basic knowledge of optics in addition to electronic circuitry.

Petrochemical Processes

Process controls for a typical petrochemical plant for recovering 99.5 percent pure nitration grade benzene[2] are shown schematically in Figure 3. The process involves three steps: (1) prefractionation of the petroleum stock to prepare a concentrate fraction containing the aromatic benzene; (2) dis-

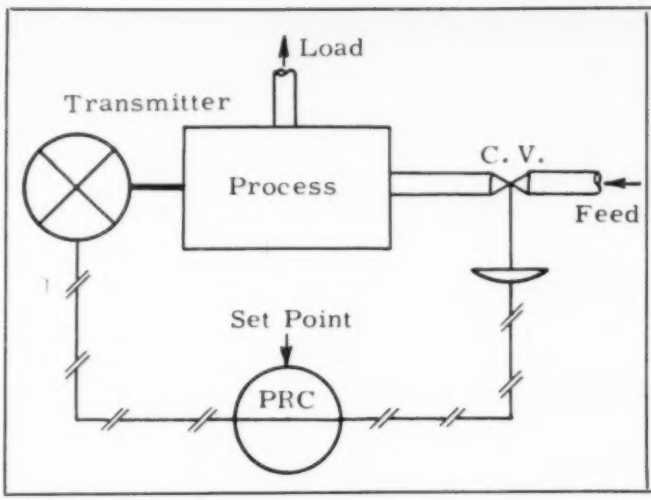


Figure 4. Pneumatic control circuit.

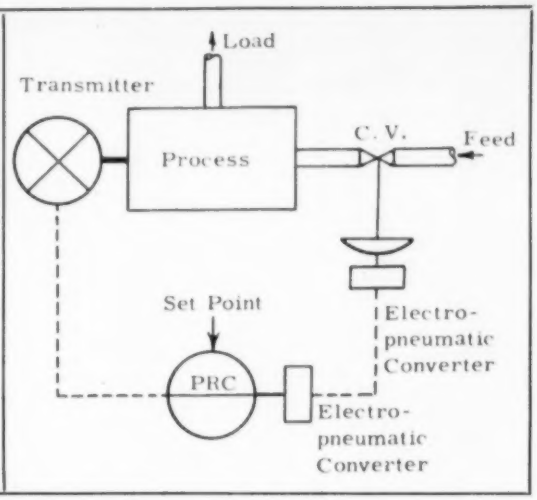


Figure 5. Electro-pneumatic control circuit.

tillation of the fraction in the presence of a high-boiling solvent such as phenol, followed by stripping of the benzene from the solvent; and (3) a mild treating step such as a caustic and water wash to meet the stringent color test. Recovery of 1000 barrels per stream day of a 99.5 percent pure benzene requires the handling of 2214 barrels per stream day of a naphtha containing 45.9 percent benzene. The utilities required per barrel of benzene are as follows: fuel, 1.1 millions of Btu; electric power, 3.3 kwh; cooling water, 3100 gallons. Approximately 13 electric motors having a total of 311 hp are used for driving the various pumps, the largest being of 135 and 90 hp for circulating cooling water and hot oil respectively. It is of interest that each of these pumps have steam stand-by equipment, which are automatically started in the event of a power failure or because of a defective motor. A power failure, while not too frequent, can be disastrous to a processing plant when it happens. In certain plants it is necessary to provide stand-by electric generating equipment to handle such emergencies, particularly where steam operated pumps have not been installed because of economic reasons.

In controlling the above process some 35 instruments are used: 8 flow recorders, 10 flow recorder controllers, 8 level controllers, 1 pressure recorder controller, 1 oxygen recorder, and 7 temperature recorder controllers. All of these instruments, except the last two items are of the pneumatic type. The temperature recorder controllers are of the electro pneumatic type, i.e. temperature is recorded electrically, the sensing element being a thermocouple or resistance thermometer. The control valve is operated from a pneumatic signal initiated by the recorder through a pneumatic control mechanism which embodies variable gain, rate and integral control adjustments.

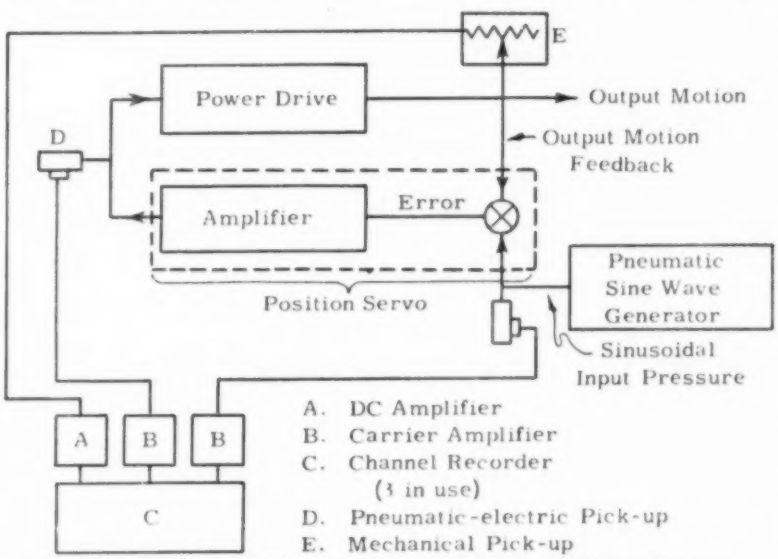


Figure 6. Equipment for obtaining frequency response data of pneumatic position servo.

Fast Acting Controls

As demand for products increases production must keep step to satisfy the needs. Under such conditions process control systems must operate without delay and faster control functions are required to permit smooth operation. Pneumatic systems are continually being improved in the direction of decreasing delay times in a control system. In some processes the control valve necessarily must be placed at a considerable distance from the recorder controller producing the pneumatic signal to operate the valve. The long air line from the controller to the valve may introduce undesired delays in the valve operation. For example, Bradner[3] has shown that a ⅜-inch copper tube line 500 feet long produces a transmission lag of 7 seconds for pressure build-up to 95 percent of final. These measurements were made with an infinite capacity source system and a terminating bellows which can be considered dead ended. While it is not the intention to discuss transmission lags in detail it is sufficient to point out that, usually, measurements of lag are made under specified conditions. Hence data obtained depend on capacity of pilot valves for supplying air and on the size of valve terminating the line.

MAINTENANCE / OPERATION

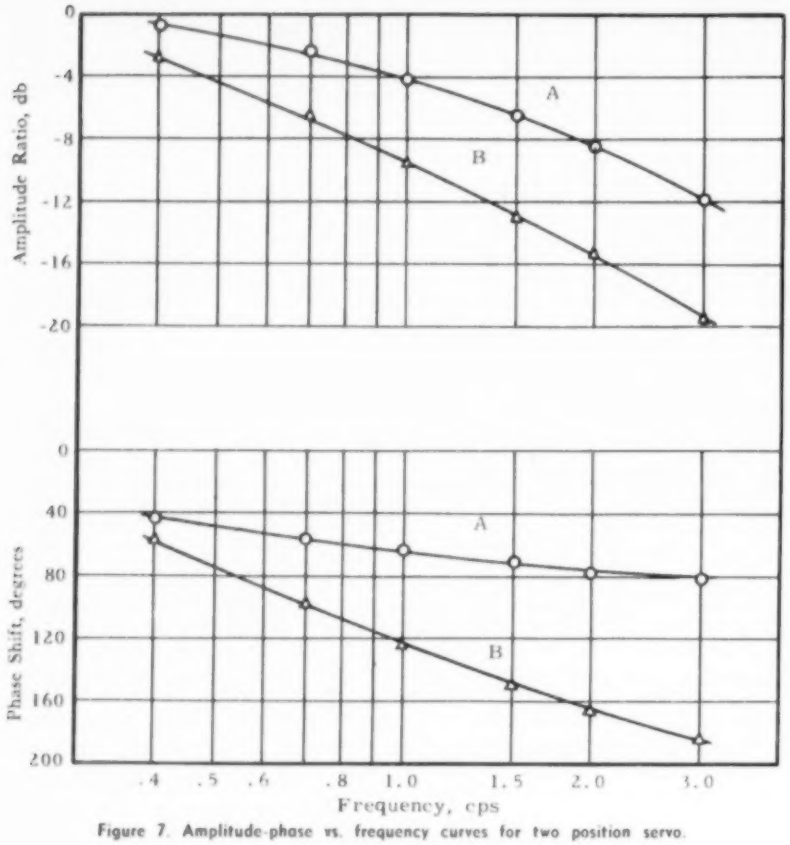


Figure 7. Amplitude-phase vs. frequency curves for two position servo.

Therefore transmission lags in certain practical cases may be higher or lower than seven seconds. Figure 4 shows in a schematic form a pneumatic control circuit. Advantages of such a control circuit are: low initial cost, ease of maintenance, dependability, and no explosion hazard. Disadvantages are: slow speed of response, requires instrument air supply system, and orifices have a tendency to plug because of dirty air.

To minimize transmission lags and for controlling fast processes it is felt by many authorities that important advances will be made by the adaptation of electrical and/or electronic devices to process control. This is a trend at present just as a few years ago the trend was toward the development and utilization of quality control instruments which is a realization today. Thus functions being presently performed pneumatically with the possible exception of the valve operator will be done by electrical means. Figure 5 shows schematically an electro-pneumatic control circuit for minimizing transmission lags. Advantages of this control circuit are: high speed of transmission and signals can be transmitted over long distances. Disadvantages are that need for explosion proof equipment makes installed cost high and conduit installation is more expensive than pneumatic tubing.

Frequency Response Techniques

Because control instruments are more than ever being considered a part of the process a knowledge of dynamic characteristics of the instruments and the related control system is of importance for obtaining optimum control. Techniques similar to those used in designing feedback amplifiers, including frequency response, are now being used as a means of obtaining dynamic characteristics of process control systems.[4,5]

A typical arrangement of test equipment used in this laboratory for obtaining frequency response data is shown schematically in Figure 6. In place of an audio oscillator a pneumatic or mechanical sine wave forcing function generator is used at the input with suitable pneumatic electric or mechanical electric transducers being connected to the input and output of the device under test. The output signals from the pickups are amplified to the required level for operating a multi-channel recorder in place of an oscilloscope.

Strain gage type pressure pickups are normally used with pneumatic devices and linear potentiometers for mechanical motion. The recorders have a flat frequency response up to approximately 25 cycles per second. This frequency spectra is found to be quite adequate for most types of process control systems. Chart speeds are adjustable from 0.25 to 50 mm. per second. The frequency range of the sine wave generator is continuously adjustable from one cycle per 30 minutes to 20 cycles per second. Adjustments are also provided for amplitude and d.c. level.

Frequency response curves, shown in Figure 7, were obtained by using the above described equipment on two commercial types of pneumatic position servos, which are used to position power drives in process control systems. Amplitude ratios in decibels and phase lag in angular degrees are plotted against frequency in cycles per second on a log scale. The two systems were tested on the same power drive. The (A) servo proved to be better than (B) since it introduces less phase shift in the control loop and it is capable of following faster changes. While (A) is more stable within itself (B) could become unstable by introducing friction in the power drive which is common in actual practice. When friction was introduced at the power drive the frequency response tests of servo B showed that the phase angle increased to the 180° point at a lower frequency than the zero d.b. gain point on the amplitude ratio curve. This created a condition of unstable action within the system. From this information it was possible to select the most desirable of the two types of position servos for a particular application.

ACKNOWLEDGMENT

The author wishes to acknowledge assistance of W. L. Snider for information on process controls used in benzene extraction; and to my colleagues Paul Hoyt, Ben Stanton and Will Deissinger of the Instrumentation Department for the data on frequency response presented herein.

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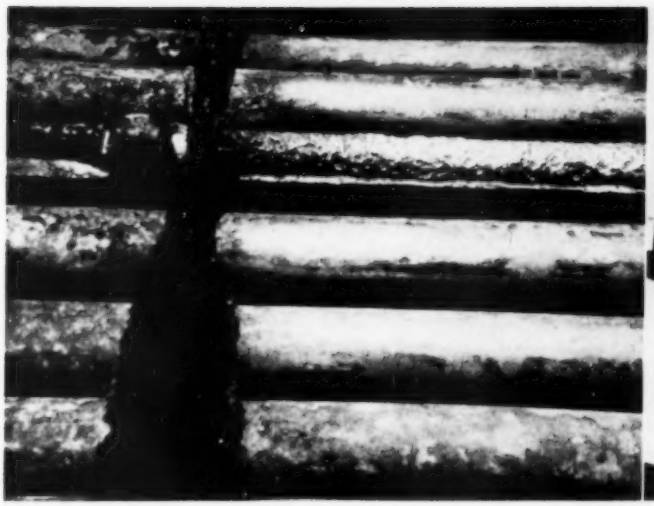
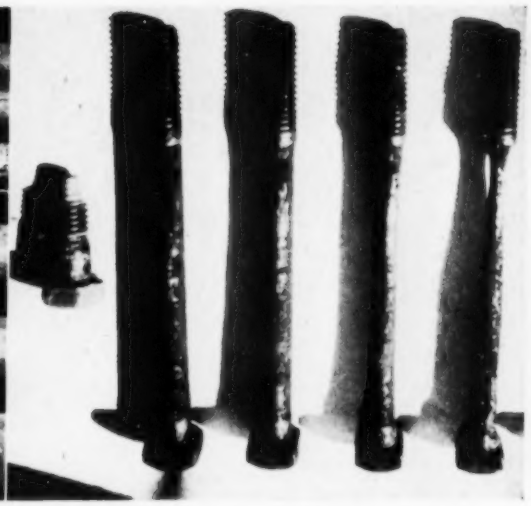


Corroded heat exchanger bundle after 15 months in service.



Corroded holddown bolts for distillation unit.

Casebook of a Corrosion Chemist

Maxey Brooke, Phillips Petroleum Company
Sweeny, Texas

MUCH OF THE WORK of a corrosion chemist or corrosion engineer deals with "text-books" cases. These are corrosion problems whose patterns are so common that they have been repeated many times. Text-book solutions can be applied to most of these problems. A typical example is the decomposition of magnesium chloride in topping stills releasing hydrogen chloride in the overhead product. This frequently causes severe corrosion in overhead lines, exchangers, condensers and accumulators. The text-book solution is to inject ammonia into the overhead line in sufficient quantity to neutralize the hydrogen chloride.

Occasionally something unusual occurs: a new corrosion pattern, an environmental change, a unique solution to a problem.

The solution of a corrosion problem by trial and error is costly. But if an engineer has the report of some one else who has solved the same or a similar problem, the cost can be minimized. Hence these reports.

1. The Case of the Condenser Tube Sheets

Problem: Active corrosion was taking place on the water side of the steel tube sheets of condensers where admiralty tubes were rolled in. It was estimated from measurements that a one-inch thick tube sheet would have a life of ten years before it became impossible to roll tubes into it.

The pH of the cooling water was adjusted to 6-6.5 to prevent scaling. A phosphate-ferricyanide treatment prevented corrosion in all areas not in contact with copper alloys. An iron-admiralty couple immersed in the cooling water showed a current flow of 0.4 micro amps with a potential of 450 mv. If pieces of steel and admiralty in contact with each other were laid on filter paper wet with cooling water, a brown rust stain rapidly appeared. This was a case of galvanic corrosion.

Remedy: On several exchangers, naval brass or naval brass plated tube sheets were installed. At first it was feared that this substitution would simply transfer the corrosion area from the tube sheet to the channel or other adjacent steel areas. However, after 18 months operating, no metal loss has been observed.

2. The Case of the Low Pressure Reboilers

Problem: In reboilers for a deisobutanizer tower at the HF alkylation unit, general metal loss was observed in all steel parts which came in contact with the steam condensate. The loss was particularly severe on the tubes in the condensate pass.

The steam used for these reboilers was low pressure (40 psig). It came from turbine exhausts and from waste heat boilers whose makeup water was not deaerated. The carbon dioxide content sometimes went as high as 100

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Corroded portion of a downcomer on a distillation unit tray.

ppm. The metal loss was due to carbon dioxide corrosion.

Remedy: Because of the low pressure steam supply, the reboilers sometimes operated under a vacuum. Hence venting was not feasible. Octadecylamine, a filming type amine was injected directly into the steam supply header in concentrations of 15 ppm.

The iron content of the reboiler condensate ran as high as 175 ppm before treatment. After treatment it dropped to 2 ppm or less. Caution: The presence of any hydrocarbon in the steam renders this method of treatment ineffective.

3. The Case of the Fouled Hydraulic Oil

Problem: The filter screens in the hydraulic system operating the slide valves on a fluid catalytic cracking unit would become so clogged in just a few days service that the valves became inoperative.

Examination of the material on the screens indicated that it was iron oxide. It was known that there was a small amount of water in the oil. The water was coming in contact with the iron of the system and oxygen corrosion was taking place. Since oxygen is quite soluble in hydrocarbons, the oil was replenishing the oxygen in the water as fast as it was being used up.

Solution: Enough sorbitan monoleate was added to the system to make an 0.05 percent solution. This material created a water-in-oil emulsion. Since each particle of water was completely surrounded by oil, the water could not come in contact with the metal and cause corrosion.

Once the accumulated rust was removed, the screens were cleaned once a month rather than every few days. Even these cleanings were more of the nature of an inspection since the screens are never dirty enough to impede valve operation.

4. The Case of the Black Iron Water Pipe

Problem: The potable water being supplied to the refinery units and the refinery camp was "red." On contact with air or on heating, a colloidal red precipitate formed in the water giving it an unpleasant taste, caused it to stain fixtures, to clog water heaters and made it difficult to wash clothes. Localized corrosion caused holes to appear in the lines making frequent repairs necessary.

These lines were laid during and soon after the war when cast iron pipe was not available. They were common black iron pipe. The water flowing in them was saturated with air. The corrosion was simply oxygen corrosion.

Solution: A three-quarter inch line from the discharge of the main pump was connected to the bottom of a chemical pot. A line from the top of the pot was connected to the pump suction. The pot was filled with a molecularly dehydrated phosphate. The water flow through the pot was regulated with a needle valve to give a phosphate concentration in the pump discharge of 5 ppm.

The iron content of the water dropped from 25 ppm to less than 0.1 ppm. The color cleared and the taste improved. During four years use, there have been no pipe repairs necessary and no complaints from users.

5. The Case of the Reboiler Tube Ends

Problem: A gasoline stabilizer reboiler, after about six months operation, was found in the following condition: The steel tube ends at the outlet section of the condensate pass had lost up to 75 percent of their original thickness where rolled into the tube sheet. Metal loss was worse on the bottom of the tubes. In the portion just under the tubes, the tube sheets showed grooving. The metal loss was severe enough that it was estimated, even with rotating the bundle 180°, that the tube life was less than 18 months. Furthermore, in time, the tube sheet would become unusable.

The reboiler was so constructed that any non-condensable gases present in the steam would tend to be trapped in the upper portion of the condensate pass. It was known that the steam contained 15 ppm carbon dioxide but no oxygen. The steam condensate would thus be in contact with a carbon dioxide rich atmosphere which would lower its pH and render it corrosive. Laboratory analyses confirmed the low pH and high carbon dioxide content of the condensate.

Solution: One inch collars were welded on the inside and outside of the channel and a hole drilled through them. A one inch nipple was put in the inside collar long enough to reach within a half inch of the pass-rib; a short nipple and a gate valve were put in the outside collar. A steel plug with a 1/32-inch orifice drilled through it was put in the gate valve. A small amount of steam was continuously vented carrying with it any non-condensable gas.

Before installation of the vent, corrosion coupons installed in the condensate line showed a penetration of 150 mils per year. After installation of the vent, the penetration was reduced to 5 mills per year. After three years service, the tubes showed no metal loss on the steam side.

Design and Construction Of Control Valves

Every engineer and operator should have a thorough knowledge of control valve construction. Here's the complete story.

David E. Hostedler, Foster Wheeler Corporation, New York

CONTROL VALVES are the nerve centers of all refinery processes. If in one fell swoop all control valves should cease operating, the nation's refining industry would be shut down in a matter of minutes. Certainly then such important equipment is worthy of the most detailed study. This article gives a critical analysis of the more important features in the design and construction of control valves.

The starting point for valve design information should be the valve body. This, in the most common type, is very close in pattern to the conventional hand-operated globe valve, except that in sizes over $\frac{3}{4}$-inch it is usual for the control valve body to have double seats, which reduce most of the unbalance in force caused by pressure drop. For control work, double-seated valves have such desirable qualities, which account for their quite universal use in sizes as large as 16 inches. Since one disc seats in the direction of the pressure drop while the other is in opposition, the thrusts substantially balance and a reasonable force can position the plug. This permits a motor of practical size to handle larger valves and higher pressure drops. The result is lower cost and simplicity of design. On the other hand, a double-seated valve cannot be depended upon for tight shut-off when this is required in addition to control. For such applications the single-seated type is indicated; but then much care must be exercised because of the unbalanced force across the disc. A very powerful operator may be needed. Also, this unbalanced force must be counteracted by the diaphragm top, and for any particular instrument loading pressure, the plug can assume a different position with a change in pressure drop across it. With varying pressure drop, poor control can result.

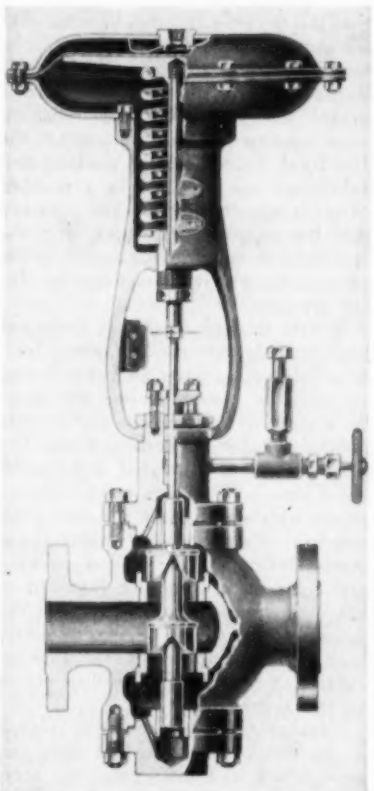


Figure 1—Cutaway view showing construction of typical diaphragm control valve.

For some applications an angle type of body can be used to advantage. It is in principle also single-seated, and has most of the good and bad features of the single-seated globe style. It does eliminate any tortuous passage between the port opening and the outlet; and is often used where high pressure drop and resultant high velocities, or abrasive solids in the fluid, would cause erosion from impingement downstream of the port. Special types of angle bodies, with streamlined internal body passage and venturi style exit cone, are used for some extreme applications.

End Connections

Valve bodies may have either screwed or flanged end connections. The valves with threaded ends are commonly used in sizes up to and including $1\frac{1}{2}$ inches, except in high pressure or special services where threaded joints would be unsatisfactory. Because of the obvious advantages of flanged ends, they are preferred for valves two inches and larger, and some users are willing to pay the higher cost of flanged valves in smaller sizes for the ease of removal. Flanged ends are obtained readily in the various standard types and ratings, including ring joint facings for higher temperatures and pressures. It is manufacturer's practice to avoid too large a variety of patterns, and it is usual to find a flanged steel body cast in a minimum of 600-pound ASA rating. For 300-pound and 150-pound ASA ratings, flanges are merely machined to the proper dimensions. Thus it may cost a manufacturer more to produce a body for a 150-pound rating than it would for the higher standards, and the selling price for ratings through 600-pound class may be the same. Many users specify a minimum of 300-pound to obtain the additional strength and greater flexibility for possible future installation. The equivalent follows for cast iron valves, with a minimum of 250-pound class being used. Here some care must be observed in the larger sizes since there may be a distinct difference in price.

Face-to-Face Dimension

Until the last few years each manufacturer supplied bodies which differed entirely in the face-to-face and other physical dimensions. Recently the manufacturers of such valves reached agreement on a standardized face-to-face dimension, and today most valves are identical in this important respect. Manufacturers deserve much credit for this willingness to comply with this user demand; for it was a costly operation requiring new body casting patterns. Tremendous advantages in installation work have been accomplished for the user.

Bonnets

For smaller sizes of screwed valves, particularly in high pressure ratings where temperatures are below 450 F., the bonnet structure is threaded into the valve body. In flanged construction, the casting is designed with a flanged connection for the bonnet and a simi-

lar closure at the bottom of the body is covered by a blind flange. Such a body is reversible for an easy change of the direction of action, and the bottom blind flange is an access for removal of valve internals from the lower side. The closure between the bonnet or the blind flange and the body is by a bolted gasketed joint. Most valve constructions utilize stud bolts for this purpose, while a few designs in steel are through-bolted type.

Plugs and Seats

Inside of the valve body is the combination of valve plug and seating surfaces that accomplishes the variable orifice opening. There are several types of valve plugs, the original no doubt being the straight poppet or quick-opening style. Such a disc, resembling that of a common globe valve, has always been used for direct acting regulators or reducing valves because the short lift needed to attain full capacity improved the closeness of control. The type is also useful for open-and-shut control, but is poorly designed for use with wide range throttling instruments. A valve for automatic control with such instruments should be capable of changing flow rates in small, well-graduated increments over a wide range. It should have a long travel and high lift of the plug with good relationship of valve opening to travel throughout its range. The first approach to this type of valve port action was to equip the disc with a circular skirt in which V-port notches were cut. Many of the valves in use today are of this style. Since the simple V-notched skirt develops only an approximately linear change of opening with lift, it is more common for the openings in the skirt to be cut to a shape that will produce a desired characteristic of opening vs. plug travel. A second type of plug used extensively is solid, with a contoured shape that produces a varying degree of valve opening as the plug moves away from the seat ring. By proper plug shape the characteristic flow curve can be as desired. Such plugs are often termed "parabolic" even though the flow characteristics may not mathematically agree. In the case of the skirted type of plug, the skirt itself may serve as a guide within the seat rings; or it may have in addition top and bottom guide bearings which prevent friction of plug movement under severe operating conditions. The solid plug has no guiding action in the seat ring and this must be accomplished by top and bottom bearings. For single-seated valves, either skirted type or solid plug, the guiding is adequate with a top bearing only.

In valves of conventional construction, the movement of the plug is accomplished by a stem extending to the diaphragm motor. One of the problems in valve design is to bring this mechanical connection to the outside of the body, and to seal or pack this mechanical motion against the line conditions. It is similar to the problem of packing any sliding stem and the methods of accomplishing it are much the same. The bonnet of the valve is equipped with a stuffing box fitted with a satisfactory packing material. A common type of packing is formed rings of asbestos impregnated with oil and graphite compound and bound together with a synthetic rubber binder.

The stem must move through the packing gland with a very minimum of friction and still maintain a pressure-tight seal. To do this it is essential that the packing be well lubricated at all times, and control valves should be equipped with a lubricator for this purpose. Most lubricators use a stick grease designed for both reducing stem friction and sealing against the line fluid. Since both the packing and lubricants are supplied in a number of types depending upon the pressure and temperature conditions, and the line fluid, it is advisable to obtain the manufacturer's recommendations for the service.

Within the last few years there has been considerable use of Teflon, both as a form of packing and in a design to serve as a seal around the stem. As a packing material the use is quite similar to other types of packing. The use as a seal is somewhat different. A solid piece of Teflon is machined to a shape which will cause the line pressure to effectively seal against the stem. Ordinarily the Teflon packing and seals do not require lubrication, but it is extremely important that the finish of the stems be exceptionally high, and the diameter or clearance accurate, to prevent any cutting action on the Teflon.

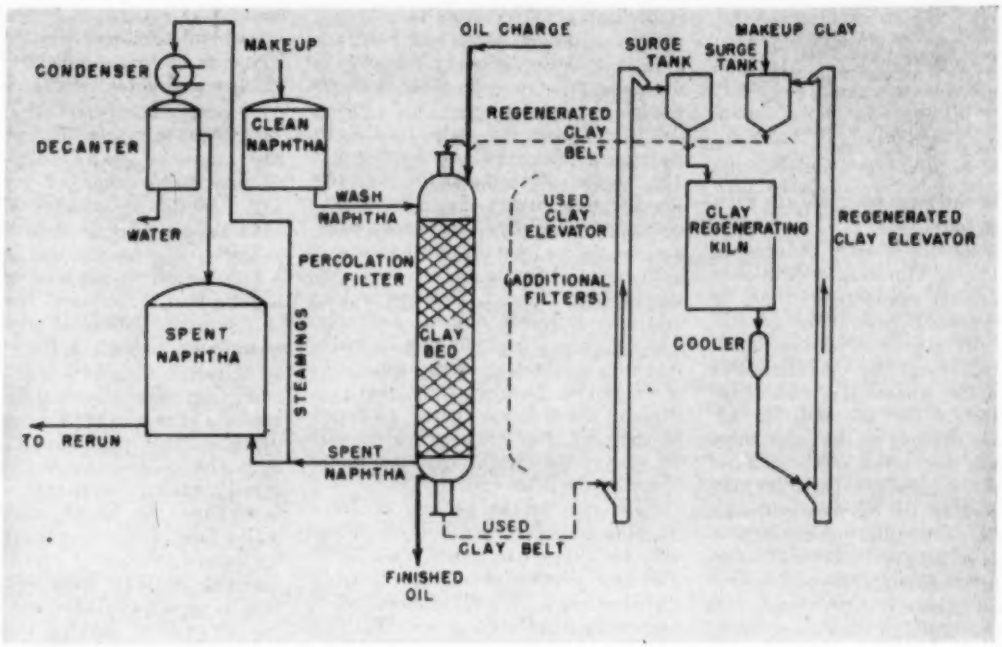
Packing glands or seals are limited in the temperature to which they can be exposed, and most valves in services above 400-450 F. should be equipped with extended finned bonnets which effectively limit the temperature at the gland. Also for low temperatures (for example, those below 25-30 F.), valves should be equipped with extended bonnets to keep the temperature at the packing gland above the freezing point and prevent formation of ice along the stem, with the resultant friction.

Topworks

The common operating means for control valves consists of a flexible diaphragm opposed by a coil spring, and most of the valves in use today are so equipped. The diaphragm used is a rubber or synthetic impregnated fabric, heavy enough to withstand the pressures and yet flexible enough to permit positioning without noticeable hysteresis. Springs are coil type, heat treated to retain their rate or characteristic. In most designs the spring is located beneath the diaphragm, in an enclosed barrel, although in some cases it is placed above the diaphragm. Generally air pressure from the controlling instrument is applied to the upper side of the diaphragm and the resultant thrust compresses the spring. The stem of the valve, therefore, moves downward with increasing air pressure and in an opposite direction on air failure. In order to reverse this direction of action for non-reversible body designs some types of topwork have a closed chamber beneath the diaphragm, sealed around the stem by means of a packing gland, and the air pressure is introduced below to move the stem upward.

The spring opposed diaphragm topwork is very simple in construction and, therefore, inexpensive. This accounts for its quite universal adaptation to all styles of control valve assembly. It does have an inherent weakness which can be only partially eliminated. Although the spring and diaphragm forces in opposition are very great, the amount of force available to move the valve stem upon a small increment of air pressure change is surprisingly small. In other words, since the force available for moving the valve must come from a differential between the force of the spring and that imposed by the diaphragm, such a topwork has theoretically no power when it is in the balanced position. This topwork is obviously limited in its ability to handle large unbalanced forces such as those of a large single-seated valve. It does have a characteristic which is usually desirable from an application viewpoint. Upon any air failure the valve will, by the action of its own spring, automatically either close or go wide open. One of these actions is desirable in a majority of installations.

Although beyond the scope of this discussion, it should be mentioned that, for types of valve requiring larger forces, there are suitable actuators available. These include air loaded diaphragms, air actuated pistons, and mechanism powered by rotary air motors, operating through reduction gearing, and equipped with positioning pilots which can provide thrusts as high as may be necessary. Such types of mechanism also are used for valves with long stem travels.



Percolation Filtration Process

Refining With Adsorbents

Part III

Percolation processes are the most widely used. Newer methods offer means of regenerating spent adsorbent.

V. A. Kalichevsky[1] and Kenneth A. Kobe[2]

PERCOLATION IS the most widely used and best known of the processes utilized for refining with adsorbents. Lubricating oils, waxes and specialties like medicinal oils are often percolated through clay before they leave the refinery. Kerosines are seldom percolated. Percolation of gasoline through clay has been recommended but not used commercially.

Commercial filters are cylindrical vessels ranging from six to ten feet in diameter and from fifteen to thirty feet in height.[76,112,115] They may hold from 10 to 60 tons of fuller's earth or double this weight of bauxite because of the difference in the apparent density of these two adsorbents. The filter sizes are not critical, but the height-to-diameter ratio must be sufficiently great to prevent channeling and formation of pockets. Bottoms of the filters may be flat or conical. If the bottoms are conical the drainage outlet should be designed so as to avoid an excessive pressure drop.

A perforated plate or pipe covered with canvas is used at the bottom of the filters for draining the filtrate. A space of one or two feet is left at the top for introducing the oil. In anti-gravity filtration the walls of the filters should be sufficiently strong to withstand the pressure of the oil column.

In gravity filtration the oil may be allowed to flow through the clay at atmospheric pressure but might be pumped under pressure to improve the filter rates if the filter walls are strong. Pressures as high as 100 psi may be applied.

Anti-gravity filtration is claimed to improve the filter yields as much as twenty percent. This improvement is caused by elimination of channeling. If filters are charged and operated properly the same yields are obtained irrespective of the direction of oil flow.

Percolation is a semi-counter current process[103] as the clay bed is stationary.

Filters used for percolating oils at high temperatures are insulated. Filters for percolating waxes are often heated from the outside of the shell with steam coils to prevent solidification of the wax.[103]

The following formulas may be useful in estimating the filter requirements:

Barrels of oil charged per filter:
$$C_f = (Y + 0.8)\,T$$
Filter turnovers per day:
$$F_d = C_d / C_f$$
Number of filters required:
$$F = \frac{F_c\,F_d}{24}$$
Daily kiln charge in tons:
$$K_d = F_d T$$

[1] Magnolia Petroleum Company, Beaumont, Texas.
[2] University of Texas, Austin.

where:
C_d—Barrels charged per day.
C_f—Barrels charged per filter.
F—Number of filters required.
F_c—Filter cycle in hours.
F_o—Filter turnovers per day.
K_d—Daily kiln charge in tons.
T—Tons of clay per filter.
Y—Yield in barrels per ton.

Calculations must be made for each stock separately.

Adsorbents are usually charged to the filters first. Vibrating devices may be installed on commercial filters to improve packing. Sometimes adsorbents and oil are charged simultaneously to speed up the operation and to reduce the possibility of channeling. Unless the oil and the adsorbent are charged at the same time, the valve at the bottom of the filter is kept open to release air. The filter may be shut off after the oil shows through to establish the equilibrium conditions, but this is seldom necessary with commercial filters having a deep clay bed.

The first filtrate is often cloudy and might be returned to the charge stock. The cloud caused by the fine clay particles disappears and the filtrate is discharged into the receiving tanks.

The color of the filtrate darkens gradually as the clay becomes exhausted. The operation is discontinued when the color of the oil in the receiving tanks reaches the desired level. Sometimes the filtrate is collected in special tanks after the color is passed until the color of the filtrate reaches that of the charge stock. This "half-stock" is refiltered to color specifications. This method increases considerably the yield of oil per ton of clay but requires additional tankage and filter capacity.

The oil charged to the filters must be dry. Moisture is adsorbed by the clay and reduces the clay efficiency. If oil contains moisture the color of the filtrate darkens rapidly. On continued percolation the color will darken beyond the color of the charge as the coloring matter adsorbed by the clay at the beginning will be desorbed by the water. After all the coloring matter is desorbed the color of the oil will lighten to that of the charge stock.

After the clay is exhausted the filter is drained and washed with naphtha. Washing is continued until the oil is removed but before the coloring matter enters into naphtha solution. Some of the refineries stop washing the filters when the oil content of naphtha leaving the filters is about two percent. The plant operators may follow it by changes in gravity or color of the naphtha. The gravity of the naphtha leaving the filters when washing is discontinued is 1-2° API lower than that of the fresh naphtha. Naphtha is removed from the clay by steaming until no more hydrocarbons appear in the condensate. The clay is then removed from the filters and regenerated by burning.

Oil is recovered from the wash naphtha by distillation and refiltered. The choice of naphtha for washing the spent adsorbents is important.[156] Naphtha should have low vapor pressure to reduce evaporation losses and a low end point to facilitate its removal from the oil. Narrow boiling fractions of 56-60° API are desirable. The nature of naphtha is important. Naphtha containing large quantities of aromatic hydrocarbons may redissolve the coloring matter adsorbed by the clay. This coloring matter will be recirculated through the filters lowering the filter capacity.

Reduction in the volume of fresh naphtha needed for washing the filters may be effected by cycle washing.[154] The first portion of naphtha leaving the filter has a high oil content and is sent to the distillation system. The rest of the naphtha is pumped for washing the next filter. Fresh naphtha equal in volume to the volume of naphtha removed from the system is used as the final clay wash. The fresh naphtha requirements may be reduced to about one-fourth of normal needs.

Effect of Temperature

Temperature has a considerable effect on the solvent properties of naphtha. Naphtha is applied first at temperatures below the temperature of the clay bed to remove the oil which is refiltered and blended with the product. Hot naphtha is used next for extracting the coloring matter which is disposed in the fuel oil blends. By removing the coloring matter soluble in hot naphtha the load on the clay regeneration system is reduced also.

Bauxite releases the adsorbed coloring matter to naphtha with a considerably greater ease than fuller's earth. In the past this has not been realized by many refineries and no changes were made in the naphtha washing procedure worked out for the fuller's earth. As a result much of the coloring matter was recycled and the filter efficiency was reduced to one-half or less of normal.

Temperatures at which the oils are percolated vary from room temperature to 100 F. for low viscosity oils or for oils percolated in naphtha solution. They may be raised up to 220 F. for percolating residual stocks. Waxes are percolated at temperatures 20-30 F. above their melting point. The available information indicates that temperatures above 220 F. may be desirable if the oil is protected from air oxidation. Such temperatures are used if the equipment is properly designed and operated. Low percolation temperatures reduce the decolorizing efficiency of clays.

Viscous stocks may be percolated in naphtha solution. The old dewaxing processes employing solvent naphtha were combined occasionally with naphtha percolation. This eliminates the necessity of distilling off the naphtha between the two operations. A light paraffinic naphtha is desirable for diluting the oil and for assisting in the precipitation of asphalt. The quantity of naphtha in the blend must be adjusted for obtaining the maximum filter throughputs. The choice of naphtha is of particular importance in percolations through bauxite which retains the coloring matter less tenaciously than fuller's earth. In plant operations the blend contains normally from 40 to 60 percent naphtha but larger volumes of naphtha may be desirable in some instances. Percolation in naphtha solution requires heating the oil to elevated temperatures for removing naphtha which may impair the color of the oil. The quantity of oil retained by the clay is less if the oil is percolated in solution. This facilitates the naphtha washing of the filters.

Naphtha losses vary widely from one refinery to another. They depend on the boiling point of naphtha and on the available equipment. In extreme instances they may reach two percent in blending, three percent in filtering, two percent in dewaxing, three percent on distillation and three percent in washing the filters.[27]

The use of propane under pressure instead of naphtha for diluting the oils in clay percolation or in clay contacting processes has been suggested. Relatively low temperatures must be used because of high pressure of propane although better results are obtained at elevated temperatures. At 160-170 F. the efficiency of clay is claimed to be improved three or four times in the presence of propane acting as a deasphalting agent.

Suggestions were made to mix the unrefined oils with adsorbents to adsorb all the oil and extract the resulting powder with solvents, like gasoline,[44] to obtain the refined product. About 150-250 percent clay may be required for adsorbing the oil but the extracted product is said to require no additional refining. Laboratory results indicate that extractions at —4 to —76 F. of residual oils in powdered form with petroleum ether or butane gives a product which can be refined with small quantities of sulfuric acid and clay to a satisfactory lubricating oil.[61] Lubricating oil may be refined in

propane solution both with sulfuric acid and clay or with sulfuric acid, sodium hydroxide and clay.

Adsorbents used in percolating the light petroleum distillates may retain a considerable decolorizing activity for residual stocks. This is seldom if ever utilized because of the danger of lowering the flash point of the oil.

Fuller's earth and bauxite are the two adsorbents commonly used for percolating petroleum. Bauxite is a comparatively recent adsorbent first applied to kerosine[76] but now utilized for percolating waxes and lubricating oils. Bauxite is more expensive than fuller's earth on volumetric basis, but it may offer definite advantages.

The decolorizing efficiency of bauxite varies with the type of stock treated and the degree of decolorization required. It may be higher, equal or lower than that of fuller's earth on the weight basis. Usually bauxite displays its highest efficiency in the dark color ranges. Bauxite is generally a better deodorizing agent than fuller's earth which explains its wide use in percolating waxes. One of the main advantages of bauxite is its ability to withstand high regeneration temperatures without an appreciable loss in efficiency.[58] Fuller's earth is discarded after several burnings while bauxite is reused continually.

Regeneration of Percolation Adsorbents

Percolation adsorbents are regenerated by burning. The burning temperature is very important for preserving the efficiency of adsorbents at its maximum.[151]

Degradation of the decolorizing efficiency of clays is caused by the irreversible changes in their structure at high temperatures. This is due to the loss of structural water and the transformation of aluminum oxide from an active to an inactive variety.

The temperature to which the adsorbent should be heated during regeneration depends both on the nature of the adsorbents and on the service for which the adsorbent is used. Bauxite can be heated several hundred degrees higher than fuller's earth without deterioration. The following example illustrates the effect of the regeneration temperature on the efficiency of bauxite.

The optimum temperature for regenerating bauxite used for percolating residual stocks in naphtha solution is 1600 F. provided the color of the product is 7½ ASTM or darker.[101] This maintains the decolorizing efficiency of bauxite at 80-90 percent of the fresh bauxite. If the same stock is percolated to a 5-ASTM color the efficiency of bauxite regenerated at these high tempeatures is only 55 percent. The high regeneration temperatures are also harmful if bauxite is used for percolating light lubricating oil distillates. For these types of oils bauxite should be burned at the lowest possible temperatures. Likewise the best results are obtained by percolating residual stocks at high temperatures and distillate stocks at low temperatures. This demonstrates that unless both burning temperatures and conditions at which the oils are percolated are properly adjusted, the experimental data may be conflicting.

In commercial practice segregation of percolation adsorbents according to the type stock treated is seldom feasible. Clays burned at high temperatures cannot be restored in their efficiencies by reburning at low temperatures. As a compromise the refineries are burning the clays at a uniform temperature based on plant experiences and on the available equipment.

Maintenance of uniform regeneration temperatures within the kiln is extremely difficult. This might be approached in the laboratory equipment much closer than it can be done at the plant. For this reason a clay may be regenerated successfully many times in the small experimental kilns while the same clay will deteriorate rapidly at the refinery. Portions of the clay burnt at high temperatures are deactivated permanently. The average kiln temperature is of little significance, if local overheating is not eliminated. Fuller's earth is much more susceptible than bauxite to local overheating and has to be discarded after several regenerations. Similarly to bauxite, the decolorizing efficiency of fuller's earth on repeated regenerations falls off more rapidly with the light than with the dark colored oils.

Local overheating is caused by the uneven distribution of clay and air within the kiln and by the unequal quantities of oil in the spent clay removed from the filters. In this respect the modern kilns are a big improvement over the kilns used originally by the industry.

The average kiln temperature used for expelling moisture and for hardening the fuller's earth at the refinery is about 700 F. Regeneration is done usually at 1050 F. The maximum temperature that might be tolerated due to local overheating should not be more than one hundred degrees higher than the average temperature. Temperatures of 1350-1400 F. are suggested in the literature and heating the clay for 4-5 seconds at 1425 F. followed by rapid cooling is said to improve the decolorizing efficiency of some clays, but these are exceptions. Bauxite is burned often at the same temperatures as fuller's earth but it is much less affected by overheating and high average burning temperatures may be permissible.

The clay regeneration equipment first used by the refineries was the same as that employed for burning ores requiring no close temperature control. Rotary kilns and multiple-hearth furnaces were developed at a later date,[100,130,136,144,167] and are used widely. However, these operations are now controlled with a considerable care. The burning temperatures are regulated whenever possible by the amount of air or flue gas admitted to the kiln. Mixing spent clay with the partially regenerated or with the hot regenerated clay has been suggested. A thermofor kiln[145] was developed. In this kiln the spent clay is charged at the top and is allowed to gravitate countercurrent to the stream of air admitted at the bottom.[166] Heat is removed or supplied by circulating a mixture of molten salts through tubes located inside the kiln. These salts are a eutectic mixture of sodium nitrite and potassium nitrate. Mechanical loss in burning clays is about two percent per cycle.

Attempts were made for improving the clay regeneration by adding to the clay small quantities of oxidation catalysts. Some of them, particularly iron, copper and zinc, had an unfavorable effect on the decolorizing properties of the clay; cadmium and aluminum were the possible exceptions.[121]

The density of the overburned clay particles is considerably higher than that of the fresh clay. Sometimes gravity separators are used to remove them from the rest of the clay.[165] Magnetic separators were suggested for bauxite containing iron.

Carbonaceous matter left on the clay after burning varies from one to six percent by weight. Complete removal of carbon requires an excessive residence time in the kiln. Under certain conditions this carbon may improve the decolorizing efficiency of clay as activated carbon can be prepared from oil or petroleum coke. On standing, the efficiency of this carbon deteriorates.

A modified percolation process of continuous type has been proposed. The clay moves in a continuous stream through filters to the kiln and after regeneration is returned to the filters.

End of Part III. Part IV will appear in an early issue.

European Refinery Capacity Up

The important factors of this expansion are

- **Locating refineries at consumption points**
- **Rising product consumption**
- **Closing of Abadan refinery**

EXPANSION OF refinery capacity in the postwar years in Europe has been greatly accelerated by a combination of causes which may well be regarded as exceptional, according to the findings of the Third Report of Oil Refinery Expansion in O. E. E. C. (Organization for European Economic Co-operation) countries.

The most important of the factors pushing refinery expansion in these countries were listed as:

The trend to locate refineries at the points of consumption in Europe instead of at the sources of crude oil supply and thereby providing an alleviation of the balance of payments difficulties and an outlet for rising crude oil production in the Middle East.

The very rapid upward trend in consumption since the end of the war.

The closure of the Abadan refinery of Anglo-Iranian Oil Company when the Iranian government expropriated the company's holdings in the country.

The latest forecast of the O.E.E.C. oil committee shows that by the end of 1953 member nations will have installed distillation capacity of 1,961,800 barrels daily and by 1954 the capacity will be increased to 2,120,700 barrels per day. (See Table 1). Estimated crude oil thruput through the O. E. E. C. plants by the end of this year will average 1,695,700 barrels a day and a year later the forecasted runs will average 1,880,000 barrels per day.

Thruput of O. E. E. C. refineries by the end of 1952 had attained the level previously anticipated by the oil committee for the 12-months period ended June, 1953. With the increased capacity in the participating nations, Europe now occupies an important place in world refining, increasing the continent's position from a prewar 5 percent to about 13 percent as over the start of 1953, O. E. E. C. participating countries are Austria, Belgium, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxemburg, The Netherlands, Norway, Portugal, Sweden, Switzerland, Trieste, Turkey and the United Kingdom. The increase in refined products output of the individual nations is shown in Table 2.

TABLE 1
Crude Thruput and Refining Capacity in O.E.E.C. Area*
(Barrels per day as of December 31 annually)

YEAR	Crude Oil Thruput	Distillation Capacity	Reforming Capacity	Cracking† Capacity	Lube Oil Capacity
1951	1,150,900	1,436,700	130,500	132,100	35,560
1952	1,445,900	1,641,800	156,350	223,800	37,730
1953	1,695,700	1,961,800	185,300	361,600	50,690
1954	1,880,000	2,120,800	206,100	395,400	57,340

*Excludes Austria.
†Thermal and Catalytic.

Total cracking capacity of O.E.E.C. participating nation refineries is expected to increase from 132,300 barrels daily in 1951 to 395,500 barrels per day by the end of 1954. The expansion of cracking capacity is largely due to the erection of catalytic cracking units which are scheduled to go on stream in 1953, and of which the capacity will attain 314,300 barrels daily by January 1, 1955. Regardless of the increase in cracking capacity, which is substantially higher than anticipated in the committee's second report, the proportion of catalytic cracking to distillation capacity is expected to be only 14 percent by 1954. The comparable figure for the U. S. is 34 percent.

Consumption of petroleum products in Europe, which rose from a prewar rate of 620,000 barrels daily to a 1952 demand of 1,383,000 barrels per day, was the most important influence behind the need for European refinery expansion. When the program for European economic recovery was first drawn up in early 1948 one of the chief aims of the over-all economic plan and the refinery phase of it was to save foreign exchange by reducing, if not eliminating, Europe's dependence upon imported finished petroleum products. The rising demand curves of European nations, coupled with rising production from the Middle East, and the critical dollar shortage in Europe were among the factors contributing to the reconsideration of the prewar and immediate postwar practice of locating refineries close to the source of the raw material.

TABLE 2
Refined Products Output of O.E.E.C. Nations
(Annual Basis in Barrels Per Day)

COUNTRY	1951 Actual	1952 (Partly Estimated)	1954 Forecast
Austria	17,520	20,000	n.a.
Belgium	18,200	53,200	90,000
Denmark	460	560	560
France	370,700	432,100	442,200
Germany	101,400	106,800	194,900
Italy†	149,700	196,600	277,100
The Netherlands	143,500	160,800	225,900
Norway	810	1,050	900
Portugal	7,200	9,500	12,900
Sweden	23,100	28,100	36,000
Switzerland	1,100	1,100	4,000
Turkey	220	280	n.a.
United Kingdom	334,400	455,900	595,500

†Including Trieste.

An additional motive for erection of complete capacity for domestic needs within the consuming nations was the developments in Iran that ended in expropriation and shut-down in July, 1951, of the Iranian oil industry. Participating O.E.E.C. countries had been dependent upon Iran for about 140,000 barrels daily of products and 90,000 barrels per day of crude oil, or combined approximately 16 percent of their total product consumption.

The rapid construction of refineries in European nations has reached the level that by the latter part of 1951 European refineries were participating in export movements of petroleum products eastward. Reports of traffic in the Suez Canal for the final six months of 1951 show that the volume of petroleum products in the north-south movement (i. e. from Europe to India and Asia) through the canal was at an annual rate of 40,000 barrels daily. In 1952, a total of 4 million metric tons of petroleum products (80,000 barrels daily) from European refineries passed through the canal. About 30,000 barrels daily came from French refineries, 28,000 barrels daily from the U. K. and 18,000 barrels per day from Europe.

Flame spectrophotometer with flame in operation. (Both photos courtesy Beckman Instruments, Inc.)

Determining TEL in Gasoline By Flame Photometry

- High Speed
- High Accuracy
- Low Cost

John H. Jordan, Jr., Magnolia Petroleum Company, Beaumont, Texas

SEVERAL methods are available for determining the tetraethyl lead content of gasolines. The chemical methods are universally applicable but they are time consuming. The polarographic method now in common use is faster than chemical methods although the lead must be extracted chemically from the gasoline. The direct polarographic method still requires half an hour time because the sample is treated with chemicals. The X-ray absorption method utilizes expensive equipment, available only in a few laboratories. The flame photometric procedures are fast and make use of relatively inexpensive equipment that can be used for many other tests.

The modified flame photometric procedure described below is applicable to refinery blends of approximately constant composition such as are encountered in the manufacture of high grade aviation gasolines. A slight error might be introduced in testing samples of motor gasolines which are prepared from a variety of refinery stocks. The possibility of error is increased if the method is applied to unknown samples of gasoline.

The photometric methods[1,2] assume the existence of a linear relationship between the quantity of lead present and the intensity of the spectral line. One of the procedures requires the use of a blank, free of tetraethyl lead, which is not always available. The linear relationship seldom holds over a wide range of tetraethyl lead concentrations. Deviations from this relationship are dependent upon individual burner characteristics and vary with the life of the burners. This may introduce an analytical error as high as 10 percent.

The present method minimizes the error by using a standard of approximately the same composition as the unknown sample. The lead content of the standard should be within 0.5 ml. TEL per gallon of the sample in order to avoid the error of wide extrapolations. The standard may be selected from the current refinery production and its lead content ascertained by the ASTM D-526 method. By following the procedure outlined below analysis may be completed in less than ten minutes.

A quartz spectrometer employing a hydrogen flame and having a photomultiplier attachment has been used in this work. As a safety precaution, a tight-fitting cap is placed around the capillary in such a manner as to cover the breaker when the sample is in position under the burner. A polyethylene top from a pint bottle is suitable for this purpose.

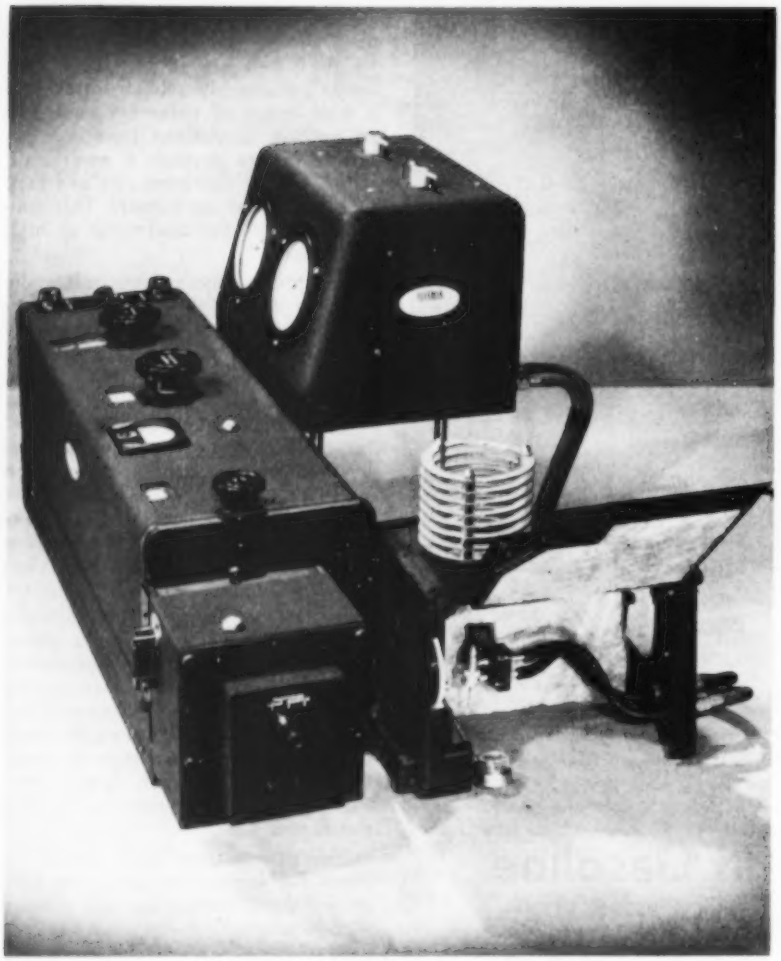
The settings vary with the instrument. For the spectrophotometer used in this work, conditions were selected as follow:

Selector Switch	1.0
Photomultiplier Switch	"on"
Resistor Selector	No. 2 position (22 Megohms)
Wave Length	406.0 mu
Slit Width	0.05 mm
Sensitivity	Counterclockwise
Oxygen Pressure	25 psi
Hydrogen Pressure	6 psi
Flame Height	0.5 in.

Four 90-volt B batteries are used in the photomultiplier box.

In carrying out an analysis, the transmission dial is set on the basis of the TEL content of the sample. It is convenient to adjust it so that 1 percent transmission is equivalent to .05 ml TEL per gallon. Thus, to obtain the standard transmission, the TEL content of the standard sample is multiplied by 20. For example, if the standard contains 4.60 ml. TEL per gallon, the transmission dial is set at $20.0 \times 4.60 = 92$.

After adjusting the dark current reading to zero, the standard sample is burned and, with the shutter open, the meter needle is adjusted again to zero by means of the needle valve on the



Flame spectrophotometer not operating but flame compartment in view.

hydrogen supply line. A slight adjustment in the sensitivity control or in the width of the slit might be necessary.

The beaker containing the standard is replaced by the beaker with the sample and the meter needle is adjusted to zero by using the transmission dial. At least six readings are taken by using the standard and the sample alternately. The standard is handled this time as if it were the sample by making no adjustments with hydrogen supply line or the dark current. The beakers are emptied and refilled after each reading.

The TEL content is calculated as follows:

$$L_X = L_S - \frac{T_S - T_X}{20}$$

where L_S = ml TEL/gal. of standard

L_X = ml TEL/gal. of sample

T_S = avg. % transmission of standard

T_X = avg. % transmission of sample

Assuming that the average of the three readings on the standard was 92.2 and that on the sample 90.2, the lead content of the sample would be

$$4.60 - \left(\frac{92.2 - 90.2}{20}\right) = 4.50$$

By taking alternate readings on standard and sample, errors in reading are minimized and slight deviations in operating conditions are compensated for. For improved accuracy the standards are kept in sealed four-ounce bottles to protect them from evaporation. New bottles are used and the old ones discarded at frequent intervals.

The results obtained by the modified photometric and by the chemical methods are compared in Tables 1 and 2 which refer to aviation gasoline and to motor gasoline respectively. The agreement was within the permissible limits of accuracy for the aviation gasolines. The deviation was slightly greater for the motor gasolines but still within reasonable limits. The results obtained with samples of gasoline of unknown composition shown in Table 3 showed larger variations.

ACKNOWLEDGMENT

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TABLE 1

Tetraethyl Lead Content of Aviation Gasolines by Flame Photometric and ASTM Methods

(TEL Content Ml/Gal.)

Sample	ASTM D-526	Flame	Difference
1	1.80	1.78	.02
2	4.34	4.30	.04
3	4.41	4.40	.01
4	4.40	4.40	.00
5	3.85	3.86	.01
6	3.83	3.86	.03
7	4.00	3.96	.04
8	4.03	4.00	.03
9	4.00	3.94	.06
10	4.57	4.54	.03
11	3.91	3.95	.04
12	4.04	4.05	.01
13	4.31	4.36	.05
14	4.49	4.45	.04
15	3.09	3.09	.00
16	3.05	3.09	.04
17	4.48	4.50	.02
18	0.54	0.54	.00
19	0.54	0.55	.01
20	4.52	4.53	.01
Average Difference			.024

TABLE 2

Tetraethyl Lead Content of Motor Gasolines by Flame Photometric and ASTM Methods

(TEL Content Ml/Gal.)

Sample	ASTM D-526	Flame	Difference
1	2.20	2.17	.03
2	2.50	2.40	.10
3	2.53	2.55	.02
4	2.58	2.52	.06
5	2.46	2.44	.02
6	2.86	2.90	.04
7	2.17	2.14	.03
8	2.91	2.88	.03
Average Difference			0.041

TABLE 3

Tetraethyl Lead Content of Gasolines of Unknown Composition by Flame Photometric and ASTM Methods

(TEL Content Ml/Gal.)

Sample	ASTM D-526	Flame	Difference
1	2.17	2.12	.05
2	3.00	2.87	.13
3	2.88	2.91	.03
4	4.50	4.50	.00
5	0.54	0.54	.00
6	3.00	2.85	.15
7	4.53	4.52	.01
8	2.17	2.14	.03
9	0.55	0.54	.01
10	2.86	2.90	.04
Average Difference			.045

Take Another Look at Economic Pipe Sizing

Rapid method is presented for estimating piping costs in selecting the proper line size for process piping

By this method the engineer can ferret out those particular lines which require more detailed study

Howard F. Rase, University of Texas
Austin

SINCE PIPING COSTS represent a large percentage of the first cost of process plants, the selection of the most economical pipe size has been the subject of considerable study. This study, however, has often resulted in over simplifications. The resulting charts or equations have very definite restrictions which the users seem to forget almost immediately.

Pipe Lines. The design of cross-country pipe lines involving the selection of the optimum size for a line many miles in length deserves the most careful economic study and market research. At first thought the problem would seem to be one of balancing two variables, pumping costs versus pipe costs. Actually, however, the analysis is far more complex involving booster station spacing, compression ratio (for gases), and complete market studies for determining future loads and load fluctuation.

Because of the magnitude of such a project it is often desirable to prepare several alternate designs and accurate cost studies so that management can base its final judgment on reliable figures. A number of procedures have been outlined and are readily available.[1]

Process Piping. Such detailed analysis is impossible in the design of a process plant. Unlike the pipe line problem where only one line is being considered at a single design flow rate, in process plant design the engineer is faced with the selection of sizes for hundreds of lines carrying many different kinds of fluids. Some involve fluids being pumped, but many others involve no pumping whatsoever. To make a cost study on each line is completely impractical.

Investigators have therefore sought for general correlations that would yield the "economic" line size. Those lines in which fluid is being pumped received the most attention since the analysis seemed the most straightforward.

Genereaux[2,3] expressed the total pipe-operating cost as a function of diameter, cost of electric power, pump efficiency, and density and viscosity of fluid. This expression was then differentiated with respect to the diameter to determine the "optimum" diameter for minimum cost. The cost expression was further simplified by evaluating average values of the variables and a simple nomograph was constructed. Johnson and Maker[4] have made a more rigorous approach. Curves were presented which permit calculation of the required diameter with corrections for the material and power costs applicable to the particular job in question. Most recently Braca and Happel[6] have presented cost data in graphical form which permits estimation of piping material and operating costs for the determination of the optimum pipe diameter. Generalized charts are presented for optimum velocities for sizing liquid lines. Correction factors for power costs, payout time, etc., are presented to permit application to various situations.

Perhaps the most grievous errors that have been made by economists can be traced to the human desire to simplify even the most complicated economic problem to the point where preferably two readily comprehended variables may be studied with mathematical precision. Unfortunately very few, if any, economic problems can be thus simplified.

Economic forces involve human factors the comprehension of which requires the experience and judgment of gifted individuals. As engineers we often prefer to think that engineering economic studies are free from these uncertainties. Perhaps this attitude can be attributed to the ease with which simplified expressions for operating and investment costs can be equated to the size of a given piece of equipment and the expression solved for minimum cost by differentiating and equating to zero. The solution is so logical, straight-forward and clever that we are reluctant to look at the original simplifying and often erroneous assumptions that made the mathematical manipulations possible.

What Power Cost? The big problem is what cost figure should be used for power. Unlike the long pipe line problem in which power is purchased and actual power costs can be obtained from the potential supplier, process plants very often produce their own power. If it is a new plant, actual costs will not be available. Even if the construction is in an existing plant, the figure used by the plant depends upon the philosophy of the particular accounting system and it may or may not be a realistic value suitable for engineering study.

Line Sizing Procedure. Calculation of the pressure drop through a given size line at a specified flow rate of any fluid is now possible with considerable accuracy. The very excellent work of

Moody[6] which presents charts of friction factors for various values of relative roughness makes this possible. Perhaps one of the most comprehensive presentations of data is contained in the 9th Edition of the Standards of the Hydraulic Institute,[7] which data include that of Moody.

The problem then is resolved into what pressure drop to permit for design. Most operating companies have prepared standards which specify certain allowable pressure drops for pump discharge lines, pump suction lines, vapor and steam lines. Others specify certain maximum or average velocities. Some typical rules are:

	Reasonable Velocity*	Allowable Pressure Drop
Pump Discharge	$\frac{d^*}{2}$ + 4 in ft./sec.	2 psi/100 ft.
Pump Suction	One-third the above	0.5 ft./100 ft.
Steam or Gas	d* in 1000 ft./min.	0.5 percent of line pressure per 100 feet

* d = diameter of pipe in inches.

Reflection will further indicate that such rules or specifications are arbitrary to some degree because theoretically, at least, each situation is unique and no general rule can cover all conditions. Completely arbitrary use of such rules (if company specifications are carefully read, it will be seen that arbitrary use is never recommended) can in some instances cause considerable needless expense.

"Reflection will further indicate that such rules or specifications are arbitrary to some degree because theoretically, at least, each situation is unique and no general rule can cover all conditions. Completely arbitrary use of such rules (if company specifications are carefully read, it will be seen that arbitrary use is never recommended) can in some instances cause considerable needless expense."

These rules are based on the two common shortcut approaches to line sizing which are described by Johnson and Maker[4] as the pressure drop method, holding the pressure drop below a certain valve, and the reasonable velocity method. They emphasize that the pressure drop method is not completely rational since the economical rate of pressure drop is greater for small than for large pipes. The reasonable velocity method has advantages, particularly if a reasonable velocity is specified for each type of fluid, thus allowing for density changes. Neither method, of course, allows for changing costs of power, materials and labor. They do, however, give values near to the correct value in most average cases.

Consider the specification of 2 psi/100 feet of pipe and suppose in a given case the pressure drop calculated for a four-inch Chrome-Moly discharge line 325 feet long was just a fraction over that specified. Completely arbitrary use of this specification would dictate using the six-inch size. A cost estimate of the four-inch and six-inch alternates would indicate a $3000 savings if the four-inch line were used. Since the drop in the four-inch line is very little over that indicated by the specification, it should be selected. If the saving had only been several hundred dollars, the six-inch line would have been a better selection.

"Arbitrary" Specifications. A logical question is why use these semi-arbitrary specifications? Probably the most potent answer is that they have been used for so long that people have consciously or unconsciously come to expect their lines to carry an amount of fluid consistent with these design concepts even though it might be argued that in many cases overdesign results. This overdesign has come to be expected.

Perhaps all the horsepower a family car needs is 50, but most people expect to have 100 or more at their disposal. They want this overdesign. A 20,000 bpd crude unit is ordered. Everyone would be disappointed if it did not produce at least 40,000 bpd.

This human factor cannot be neglected in design. It is no reason, however, not to develop methods for more careful design so that the safety factor is more accurately known. The safety factors to which operating companies have been accustomed, however, cannot be carelessly tossed aside under the guise of economy because the whole economic thinking and planning of these organizations has been based to some degree on these safety factors.

What Is Needed? In the sizing of lines, specifications of the type cited above will produce a line size in 90 percent of the cases that will prove consistent with any logical economic analysis. What is needed is a method for rapidly detecting that 10 percent of the lines for which further study is justified. In the frequent instances where the choice between two adjacent lines becomes extremely arbitrary as in the example given above a quick method for determining the money involved will make an intelligent decision possible. If the price differential is small, the larger size should be used. If it is considerable, further study is justified. This further study would include a more detailed cost estimate

TABLE 1

Pipe and Fitting Prices

Base Price: Carbon Steel ASTM 106 Grade A or equal $0.105 per pound

Base Weights: (Based on carbon steel pipe)

SIZE (INCHES)	WEIGHT (LB./FT.) Schedule 10	Standard Weight	Extra Strong
2	2.64	3.65	5.02
3	4.33	7.57	10.25
4	5.61	10.79	14.99
6	9.29	18.97	28.55
8	13.40	28.55	43.40
10	18.70	40.48	54.70
12	24.20	53.60	65.40
14	36.70	55.00	72.10
16	42.10	63.00	82.80
18	47.40	71.00	93.50
20	52.70	78.60	104.10
24	63.40	94.60	125.50

FITTINGS	$\frac{L_e}{D}$, Equivalent Length to Diameter Ratio
90 Degree Elbow, Long and Short Radius	1.3
Tees, Full Size Outlet	2.1
Tees, Reducing Outlet	2.6 (12" and below) 2.1 (14" and above)
180 Degree Bends, Long Radius	3.0
Reducers, Concentric	0.50
Reducers, Eccentric	0.60
Lap Joint Stub Ends	0.80

Material Factors for Pipe and Fittings	Multiply By
Carbon Steel	1
4—6 percent Chrome, ½ percent Moly	3.25
Stainless Type 304	10.2
Stainless Type 316	16.07

TABLE 2

Flange Prices

Base Prices

(Basis: 150# ASA RF Welding Neck ASTM A-181 [Approximately 40c/lb.])

SIZE	Cost ($)
2	3.5
3	5
4	6.5
6	9
8	14
10	20
12	35

RATING FACTORS	MULTIPLY BY	
Rating	Raised Face	Ring Type Joint
150lb	1.0	...
300lb	1.22	3.5
600lb	4.3*	1.01
900lb	5.5*	1.01
1500lb	9.0*	1.01

* Use 4.0 for 600lb and above in sizes 2, 3 and 4-inch only.
† Actually an extra charge is involved, but it is small compared to total costs and differences between sizes are negligible.

FLANGE TYPE FACTORS	Multiply By
Welding Neck	1.0
Slip-On	0.65

MATERIAL FACTORS	Multiply By
Carbon Steel ASTM A-181	1.0
4—6 percent Chrome, ½ percent Moly (ASTM 182 F 5)	*3.50
Type 316 Stainless Steel	*5.0

* For 150lb and 300lb welding neck only.

and economic study together with a rigorous dash of keen engineering judgment.

The Method. A procedure is presented in the accompanying tables for rapid estimation of installed piping costs based on a careful analysis of material, erection, and fabrication costs. There are many methods more reliable than that herein presented and this procedure is not recommended for accurate cost estimation of piping. It has been designed, rather, to provide a rapid and simple method of estimating the magnitude of the cost differential between any two sizes of installed pipe line in a process plant.

In the accompanying tables base prices for each item of pipe material are given so that the data may be corrected with ease when necessary to meet changing conditions. The tables are designed as follows:

Table 1. Pipe and Fitting Prices

The cost of the pipe and fittings for a given line can best be determined on a weight basis. The length of pipe is determined from the plot plan and layout drawings and the fittings are converted to equivalent lengths of pipe using the values given. The total equivalent weight of pipe is then obtained by multiplying the length including equivalent fitting lengths by the weight per foot of pipe as given in Table 1. The cost for a carbon steel line is then obtained by multiplying the resultant weight by the base price of $0.105 per pound. For materials other than carbon steel the cost is obtained by multiplying the carbon steel

TABLE 3
Fabrication and Erection Costs

FABRICATION COSTS	Multiply Carbon Steel Costs of Pipe, Fittings and Flanges By
Material:	
Carbon Steel	1.0
All Nickel and Nickel Alloy Steels (18-8, Monel)	2.0
5 percent Chrome (no nickel) and Higher Steels	2.5

Erection Costs:

Approximately equal to cost of fabricated *carbon steel* pipe; *i.e.*, material cost of carbon steel pipe, fittings, and flanges plus fabrication cost. This also applies for alloy pipe installations if no field welding is required. If field welding is required, the following multipliers are suggested for application to the cost of an equivalent carbon steel system to allow for special fit-up and field stress relieving.

stainless steels	1.5
4-6 percent chrome	1.2

> **"Perhaps all the horsepower a family car needs is 50, but most people expect to have 100 or more at their disposal. They want this overdesign. A 20,000-barrel-per-day crude unit is ordered. Everyone would be disappointed if it did not produce at least 40,000 barrels per day."**

value by the appropriate factor listed in Table 1.

Table 2. Flange Prices

The base prices given in this table are for 150# ASA raised-face, welding-neck, carbon-steel flanges (ASTM A-181). For other materials, facings, and ratings the appropriate multiplying factors given in the table are used.

Table 3. Fabrication and Erection Costs

It was found most convenient to obtain the fabrication and erection costs on the basis of all the materials required for the run of pipe excluding valves. The total cost of pipe, fittings and flanges as carbon steel is multiplied by the factor listed to obtain the cost of fabrication. Erection costs are approximately equal to cost of fabricated carbon steel pipe (not including valves). For alloy lines requiring field welding multipliers are given.

Table 4. Valve Prices

The addition of the valve costs to

TABLE 4
Valve Prices

SIZE	Base Price (adjusted) Cost Steel 150lb O.S. and Y Gate Valve
2	70
3	85
4	120
6	205
8	290
10	400
12	530

RATING FACTORS	MULTIPLY BY: Raised Face	MULTIPLY BY: Ring Type Joint
Rating:		
(125lb)	(See Cast Iron below)	
150	1.0	
300	1.6	1.7
400	2.4	2.5
600	3.4	3.6
900	4.3	4.6
1500	6.7	7.1

MATERIAL FACTORS	Multiply By
Materials:	
Chrome-Moly 5 percent—½ percent	1.25
Monel	2.1
Stainless Steel, Type 316	1.7 (150lb only)
Cast Iron (125lb)	0.45

VALVE TYPE FACTOR	Multiply By
Valve Type	
Gate	1.0
Globe	1.2
Check	1.0 for Class 150 0.70 for all others

the above costs completes the cost study. Here again base prices are presented using 150# O.S. and Y gate valves as the basis. Prices for other valve types, ratings, and materials, are obtained by multiplying by the necessary factors as listed.

Estimation of a Given Line. Determine the erected and delivered cost of a six-inch Schedule 40, 150# ASA rating (RF), carbon steel pump discharge line which is 325 feet long and is composed of 12 flanges, 16 weld ells, 1 tee, 1 check valve, and 2 gate valves.

(a) Pipe and Fittings (See Table 1).

	L/D	Equivalent Length, feet
325 ft. pipe		325
16 ells	(16) (1.3) (6) =	125
1 tee	(1) (2.1) (6) =	13
	Total:	463 feet

Total Weight: $(463)\left(\frac{\text{lb.}}{\text{ft.}}\right) = (463)(18.97) = 8780$

Cost: $(8780)(0.105) = \$922$

(b) Flanges (See Table 2).
$(12)(9) = \$108$

(c) Fabrication (See Table 3).
Total cost flanges and pipe = $922 + 108 = \$1030$
Fabrication Cost = $(1.0)(1030) = \$1030$

(d) Erection Costs (See Table 3).
Cost = $1030 + 1030 = \$2060$

(e) Valve Costs (See Table 4).

2 gate valves	(2) (205)	= $410
1 check valve	(1) (205) (1.0)	= 205
		$615

Total Cost of System Delivered and Erected:

(a) + (b) + (c) + (d) + (e) = $4735

If this line were constructed of Schedule 40, 4-6 percent Chrome-Moly with 300# RTJ Chrome-Moly flanges, the cost would be calculated by using the appropriate factors.

(a) (922) (3.25)	= $3000
(b) (108) (3.5) (3.5)	= 1322
(c) (1030) (2.5)	= 2580
(d) (8780) (0.20)	= 1760
(e) Gates: (2) (205) (1.7) (1.25) =	872
Check: (1) (205) (1.7) (1.25) =	436
Total	$9970

ACKNOWLEDGMENT

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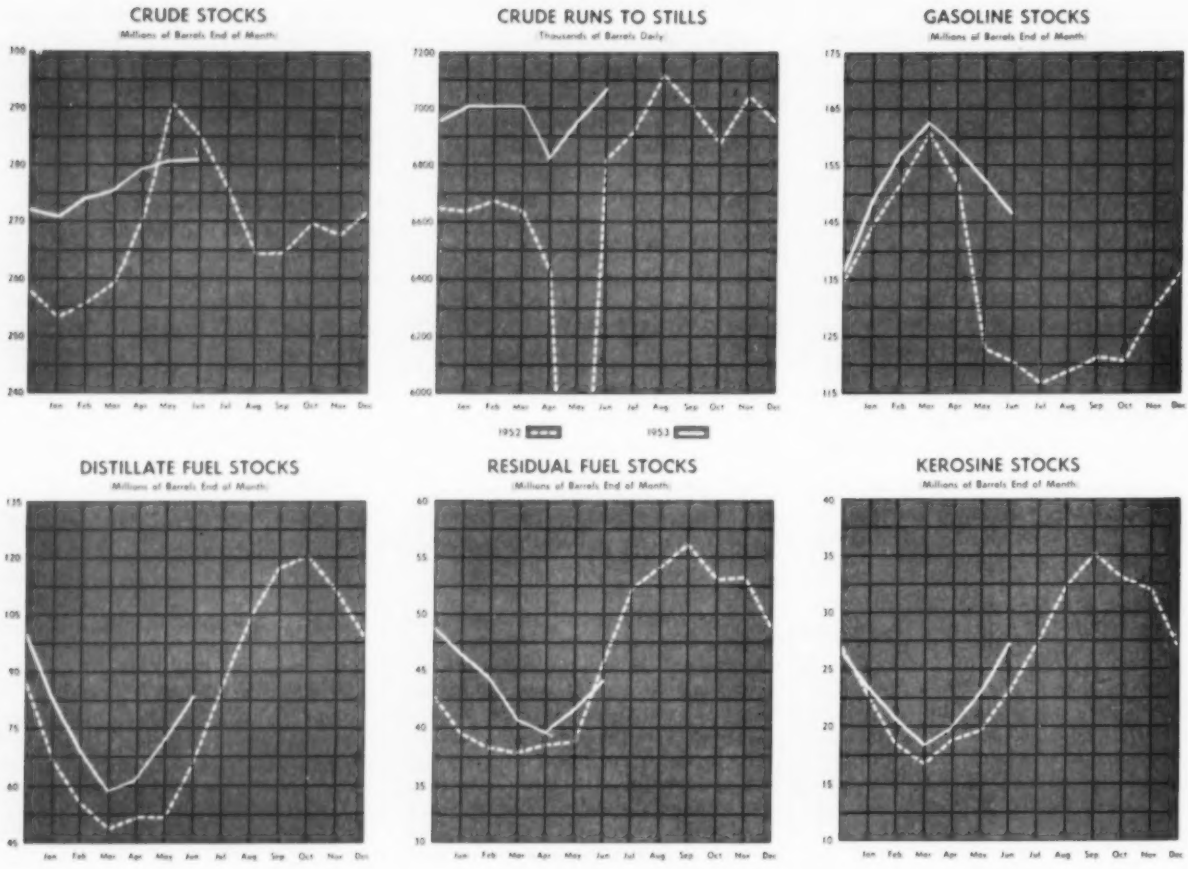

Taking Stock

Cecil W. Smith
Economics Editor

(DATA IN THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1952:													
January	6,217	6,640	254,007	3,094	144,339	421	22,679	1,456	66,969	1,338	39,523	488	951
February	6,367	6,673	255,900	3,109	151,912	370	18,530	1,528	55,369	1,322	38,295	491	940
March	6,388	6,640	259,126	3,069	160,689	386	16,817	1,400	48,750	1,274	37,971	510	947
April	6,429	6,435	270,679	2,995	151,890	366	18,955	1,312	51,634	1,253	38,561	539	922
May	5,107	4,905	290,813	2,295	123,656	229	19,614	982	51,648	979	38,821	545	951
June	6,197	6,825	285,964	3,169	120,166	317	23,061	1,455	65,911	1,228	45,688	581	901
July	6,093	6,927	275,951	3,295	116,566	358	27,387	1,475	85,775	1,237	52,245	597	892
August	6,219	7,118	264,368	3,377	118,592	375	32,401	1,514	104,257	1,252	54,061	632	879
September	6,518	7,017	264,723	3,428	120,991	350	35,021	1,502	117,252	1,230	56,200	615	902
October	6,518	6,883	269,776	3,301	120,062	352	33,289	1,458	120,721	1,203	53,052	643	1,038
November	6,487	7,049	267,852	3,416	129,509	393	32,199	1,510	116,096	1,299	53,069	624	984
December	6,634	6,952	271,928	3,361	136,028	421	26,842	1,509	99,582	1,302	48,706	603	1,165
1953:													
January	6,555	7,042	272,250	3,384	150,518	433	23,292	1,528	80,655	1,307	45,910	616	1,135
February	6,562	6,969	273,589	3,379	157,873	404	20,468	1,505	67,167	1,275	44,178	586	1,066
March	6,531	7,002	275,665	3,319	162,731	359	18,697	1,489	59,802	1,256	41,600	655	1,112
April	6,446	6,781	280,487	3,282	158,032	361	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,349	6,952	280,285	3,321	152,457	351	23,628	1,383	71,695	1,228	41,572	693	1,054
June	6,461	7,071	280,785	3,462	145,907	337	27,349	1,480	84,478	1,235	44,087	712	1,008
June, 1953—Change:													
In Month	+112	+119	+500	+141	—6,550	—14	+3,721	+97	+12,783	+7	+2,515	+19	—46
In Year	+264	+246	—5,179	+293	+25,741	+20	+4,288	+25	+18,567	+7	—1,601	+131	+107
Week Ended:													
7-18-53	6,551	7,088	279,629	3,498	143,820	322	29,644	1,534	94,912	1,254	47,779	617	843
7-19-52	6,078	6,819	282,215	3,288	117,380	329	25,128	1,447	77,361	1,254	49,596	502	796

Source: Data for last two months from API; prior monthly data from Bureau of Mines.

Will Refinery Wastes Kill Fish?

The answer is "yes," and here are the important facts on:

- **Toxic concentration level of wastes**
- **Effects of aeration, temperature and type of diluent**
- **Resistance of different types of fish**
- **Recommendations for solving the problem**

Howard P. Clemens and Phillip Summers, University of Oklahoma, Norman

REFINERY wastes may affect fish in several ways. Oil on the surface of the water eliminates the oxygen exchange between the air and the water, and fish without oxygen suffocate. Oil in the water may clog the gills to the point where they are ineffective respiratory organs. Various chemical ingredients of the wastes may be present in sufficient quantity to exert enough osmotic effect to "shrink" and kill fish. Some of the ingredients may act as poisons and irritants—they may interfere with metabolism, they may destroy the fish's appetite, or the food of the fish; they may be harmless to the older fish but kill the eggs or fry.

In refining crude oil there are a number of types of wastes which may be dumped together or kept separate. In the main part of this investigation, emulsion wastes taken from API separators were used, and caustic and acid wastes, and water from the cooling towers were not included.

Now back to the question: Can refinery wastes be dumped into a stream, with minimum damage to fish life? There are two approaches to this question. Wastes can be treated chemically or diluted sufficiently to render little or no harm to fish. A biologist leaves the first problem to the chemist, but tackles the second problem, that of dilution.

Wastes were diluted in a series of tests involving ten concentrations. Two fish were tested at each concentration. The concentration at which just 50 percent of the test animals were able to survive for the specified period of exposure was known as the standard median toxicity threshold (MTT). A 50 percent kill was used instead of a complete kill to get a value representative of the species as a whole, and not a value representing the thresholds for the more tolerant or the more susceptible fish. All toxicity procedures were conducted according to a method standardized by Duodoroff et al.[1] Chemical composition of the wastes is given in Table 1.

The strength of the effluent was measured according to its effect on a standard organism which in this case was the red shiner, a minnow readily available and found in the stream receiving the studied wastes. The median toxicity thresholds of the red shiner through the months from January to May ranged from 5 to 21 percent (Table 2). In other words, 50 percent of the fish could tolerate solutions containing 5 to 21 percent wastes. This suggests a considerable variation in the strength of the wastes from time to time.

The pH of undiluted wastes at the time of experimentation did not seem to be correlated with the median toxicity thresholds of the red shiner, Table 2. For instance, the pH of wastes on April 6 was 10.4 while the toxicity threshold was 21.1 percent. For wastes with a similar pH of 10.1 on March 23, the threshold was 5.0 percent. Even though the pH and the toxicity threshold of the wastes dropped at the same time, there was no apparent correlation.

The pH was found to change with aeration, Table 3. The pH of wastes exposed to the air at room temperature dropped from 10.3 to 9.7 in one day and kept dropping for six more days, until it reached 7.9 where it remained. When air was bubbled through wastes, the pH dropped from 10.3 to 8.4 in one day and remained there. The fall in pH to 7.9 in the unaerated sample and only to 8.4 in the aerated wastes was not explained but it is possible that the active aeration facilitated the escape of carbon dioxide into the air, or some other volatile substance that lowered the pH. Such a change in pH no longer occurred when in stoppered bottles at 6 C. This change in pH indicated chemical changes were occurring in the wastes which meant that the wastes could also be changing in their ability to kill fish.

The question was raised "does the toxicity of the effluents change?" Wastes, collected on March 6, were

TABLE 1
Chemical Analyses of the Wastes

pH —7.5		
N. C. hardness	1360	ppm.
Total hardness	1560	ppm.
Dissolved solids	2340	ppm.
S. conductance	2340	
Ca	585	ppm.
Mg	24	ppm.
Na		
K	44	ppm.
CO_3	0	
HCO_3	236	ppm.
SO_4	1390	ppm.
Chloride	8.0	ppm.
NO_3	2.4	ppm.

TABLE 2
Variations in the Median Toxicity Thresholds and pH, 1952

Date of Collection	Date of Experiment	No. of Fish	MTT Percent	pH at Time of Collection	pH at Time of Experiment
Jan. 29	Feb. 2	12x10	18.8	9.15	.....
Feb. 9	Feb. 14	4x10	15.8	.....	.....
Mar. 5	Mar. 11	8x10	6.2	.....	.....
Mar. 23	Mar. 25	12x10	5.0	10.1	10.1
April 6	April 24	12x10	21.1	10.4	10.4
April 20	April 29	12x10	18.4	9.8	9.8
May 4	May 5	12x10	18.9	10.0	10.0

TABLE 3
Changes in pH for aerated and non-aerated wastes

DATE 1951	pH of Aerated Wastes	pH of Non-Aerated Wastes
April 16	10.3	10.3
April 16 (8 hrs. later)	9.8	10.1
April 17	8.4	9.7
April 18	8.4	8.7
April 19	8.4	8.2
April 20	8.4	8.0
April 21	8.4	8.0
April 22	8.4	7.9
April 23	8.4	7.9
April 24	8.4	7.9
April 28	8.4	7.9
April 29	8.4	7.9
April 30	8.4	7.9
May 1	8.4	7.9
May 2	8.4	7.9

TABLE 4
Change in MTT With Time

Date of Experiment	Number of Fish	pH	MTT
May 5	12x10	10.0	18.9
May 12	12x10	10.0	18.8
May 15	12x10	10.0	18.5
May 24	12x10	10.0	19.0

stored in a constant temperature room at 22 C. and on March 11 the median toxicity threshold was 5.8 percent while a week later it was 14.8 percent. This variation may mean either that wastes became weaker with age or that the fish used in the second experiment were less susceptible to the wastes than those used in the first.

The second possibility was considered unlikely since the same trend occurred in all subsequent experiments with newly collected wastes but with fish from the same aquarium; also when the wastes were kept in a cold room at 6 C., toxicity thresholds remained the same. This suggested that the susceptibility of the fish did not appreciably change or that it changed in direct accordance with the weakening of the wastes, which is unlikely. On this basis the toxicity of the wastes were said to decrease at room temperature.

As previously mentioned, the toxicity thresholds remained relatively the same when wastes were stored at 6 C. This was based on an experiment involving 480 red shiners for a period of twenty days, Table 4. Such an observation suggests that wastes probably detoxify faster during the summer than the winter.

Strength of Wastes With Respect to Aeration

Aeration was found to have an effect on the median toxicity threshold and the following data, though meager, tends to bear this out. In each of the experiments in Table 5, aerated wastes had a slightly lower toxicity, meaning that more wastes were required to kill fish and consequently that the wastes were weaker.

These observations suggest a possible application of retaining the wastes in ponds and thus exposing them to the air and reducing their toxicity. Retaining wastes in ponds is nothing new and the refinery supplying the wastes used in this study employed this practice to achieve another end—that of reclaiming the oil that accumulates on the surface. A field observation tends to corroborate the possibility of reduced toxicity in holding ponds. Toxicity thresholds of wastes, Table 2, show values from 15.8 to 21.1 percent except during the month of March when they dropped to 6.2 and 5.0 percent which means that the wastes were stronger.

It was thought that different diluents might alter the median toxicity threshold of fish. The diluent in the experiments throughout this paper was unchlorinated tap water and since it was relatively high in dissolved salts, it is conceivable that such water might affect the killing power of the wastes. Simultaneous experiments where comparable data were sought on the toxicity threshold of the green sunfish, first in tap water, then in lake water, revealed that the diluents had little effect. The median toxicity threshold of the sunfish was 25.1 percent when tap water was used and 22.5 percent when lake water was the diluent. For all practical purposes the values are similar and lie near the threshold (23.3 percent) obtained from all experiments where green sunfish were used. Greater variation might be obtained with a greater variety of diluents.

TABLE 5
Strength of Wastes with Respect to Aeration

Date of Collection	Date of Experimentation	Number of Fish	MTT in Aerated Wastes	MTT in Non-Aerated Wastes
March 5	March 11	4x10	6.7	5.8
March 5	March 15	4x10	15.8	11.9
March 5	March 18	4x10	16.6	14.8

TABLE 6
Comparison of MTT of Different Species

Species	MTT	No. Fish	Size of Fish
Goldfish	33.1	6x10	3—4
Green sunfish	23.3	24x10	1.5—2.5
Red shiner	18.8	12x10	1.5—2.5
Golden shiner	18.7	6x10	1.5—2.5
Fathead	17.0	22x10	2—3

Toxicity of Wastes to Various Species of Fish

Since the strength of the wastes was never the same and the experiments were made at different times, it was difficult to obtain median toxicity thresholds that were comparable from species to species. To do this, the red shiner was used as a standard and the median toxicity threshold for each species was expressed in relation to that of the standard on January 29. Thus no matter how the wastes varied, the median toxicity threshold of the red shiner was assumed to vary likewise.

Of the five species of fish used, goldfish, green sunfish, red shiners, golden shiners, and fatheads, the median toxicity thresholds were respectively 33.1, 23.3, 18.8, 18.7, and 17.0 percent, Table 6. Four of the five species were chosen because they were commonly found in the drainage system where the pollution occurred. Goldfish were selected as more tolerant species. Preliminary experiments on bluegill, redear, and large mouth bass seem to indicate that these species may be more susceptible than any of the previously mentioned fish, but they are not found in the drainage system.

In order to evaluate the median toxicity thresholds obtained in the laboratory, field studies were set up to obtain comparable data. To facilitate these studies, stations were laid out. Station 1 was the source of the pollution and Stations 2, 3, 4, and 5 were on AP Creek which flowed into the Little Washita. Station 6 was one and one-half miles downstream from the confluence of AP Creek and the Little Washita. Station 7 was two miles below Station 6 and Station 8 five miles downstream from Station 6.

Field studies first involved finding the percentage volume wastes at each station, which was done by determining flow measurements with a pygmy current meter. At the point of discharge of the effluent, flow measurements were considered to be 100 percent wastes. Then moving downstream, if the flow measurement was double that of the effluent, the percentage volume wastes was calculated to be 50 percent and so on. In other words the effluent discharge was calculated as a percentage of the total flow, and these percentages are given in Table 7.

Unfortunately, there is another factor to consider. Effluents from the refinery enter AP Creek near Station 1, Figure 1. This is largely water from the cooling tower but it is flushed through old dried up holding ponds and here picks up pollutants. Preliminary tests revealed these wastes to have a median toxicity threshold in the neighborhood of 13.8 percent. In view of the fact that the discharge of this effluent was relatively low, around thirty gallons per minute, these wastes were calculated to make up fourteen percent of the volume of AP Creek just before the other refinery wastes enter at Station 2. Since the new wastes appear to be 1.36 times as strong as the wastes entering at Station 2, it was assumed that 41 gallons per minute of wastes equal in strength were contributed to the main effluent so that the adjusted percentage volume wastes from Stations 2 to 8 then were 66.6, 59.0, 34.1, 12.2, 10.3, 8.1 and 4.5, respectively.

These percentage volume wastes were then correlated with field toxicity studies and the distribution of fish along the course of the polluted stream. Field toxicity studies were conducted, using five jars at each station into each of which were placed two redshiners. This was a check as to whether or not diluted wastes would support fish life. All fish died shortly after they were placed in the water collected at the first three stations while all fish lived in the tests made at the last three, Table 7. Nine fish died at Station 4 where the percentage volume wastes was 34.1 while two fish died at

Station 5 where the volume wastes was 12.2 percent. The median toxicity threshold, using these determinations was 21.6 percent, slightly higher than the laboratory value of 18.8 percent which was determined using the same wastes the day following the field studies. Remember that higher toxicity thresholds mean lower toxicities and weaker wastes.

This lower toxicity is not surprising. What we have been assuming is that the wastes maintain the same degree of toxicity as they pass downstream which is not so. It has been shown that toxicity decreases with aeration and the waters are certainly aerated as they pass downstream. In addition, the increased quantities of bluegreen algae seem to indicate utilization of some of the wastes as they pass downstream. The odor it imparts indicates loss of volatile compounds which may or may not be toxic. Other compounds may be precipitated and so on. Thus one might expect wastes to become weaker, regardless of dilution.

The median toxicity threshold of the red shiner in the laboratory (18.8 percent) corresponded closely to that determined in the field (21.6) and the actual distribution of the fish during this particular determination did show signs that Station 5 was somewhat near the critical region. At the time of field evaluation, May 4, no fish were seined at Station 4, plains killifish were seined at Station 5, red shiners at Station 6, plains killifish at Station 7 and both shiners and killifish at Station 8. Monthly field studies of the flora and fauna along the stream provided further evidence. No fish were ever found at Station 4 while red shiners, fatheads, mosquito fish and plains killifish occurred at Station 5 at times but never in any numbers. The occurrence of these few fish has always been open to question since directly above this station is the confluence of an unpolluted tributary of approximately equal size to the polluted stream. The fish could easily have migrated from the unpolluted waters into those at Station 5 and might have been there long enough to be affected by the wastes. The more detailed biological examination revealed that the numbers and kinds of organisms increased in a downstream direction to Station 8 where conditions generally conformed to the unpolluted parts of the stream and were considered healthy.

In view of the soundness of applying a factor of safety to the threshold value, the improvement of the biological conditions at Stations 6 and 7 over those at Station 5, seems to indicate that at least 6 to 10 percent should be used in this particular instance. This means that the amount of wastes tolerated by the red shiner would be from 10 to 13 percent and if the red shiner factor could be applied to all species of fish, this refinery might therefore improve the conditions for fish downstream by limiting the discharge of their effluents to 10 to 13 percent of the receiving waters.

TABLE 7

Percentage Volume of Refinery Wastes for Each Station

Station	Percent Volume Wastes	Adjusted Percent Volume Wastes	Number Fish Dead
1	100	100	10
2	54.9	66.6	10
3	49.0	59.0	10
4	17.6	34.1	9
5	10.1	12.2	2
6	9.3	10.3	0
7	6.7	8.1	0
8	3.7	4.5	0
MTT	13.3	21.6	

It should be pointed out that all this is based upon only one species of fish, the red shiner, and for the red shiner on a particular day only. You will remember that thresholds of the five species of fish used varied from 17.0 to 33.1 percent and that the strength of wastes during this study varied and the range of toxicity thresholds for the red shiner was from 5.0 to 21.1 percent.

However, with core careful consideration of this particular case the threshold value of the red shiner appears to be a safe selection for the other species of fish involved. The fact that the wastes vary in strength from time to time does not appear serious in light of the limited data available. A check on the variations in strength in Table 2 suggests that the only real variation from a practical standpoint was during March when the wastes were allowed to run directly into the stream without being retained for a time.

Other types of refinery wastes not found in the effluent entering AP Creek seem considerably more toxic than the wastes from the API separators that have been used in these studies. Preliminary checks to determine approximately where the threshold values were for the red shiner indicated that acid sludge had to be diluted some three thousand times, and caustic emulsion some fourteen hundred times before 50 percent of the shiners could live.

Recommendations

The above study is not extensive enough to warrant application of the data to the conditions at any refinery. However, the strength of the wastes can readily be checked and when the discharge of the receiving stream is known, calculations can be quickly made to determine whether or not it is practical to attempt to gear waste disposal to the stream discharge. If indications are favorable then further considerations would include a study of kinds of fish involved in the stream and their median toxicity thresholds with respect to the waste that is to be dumped into the stream.

Every practice to reduce the toxicity of the wastes should be made. Although further studies are needed in this respect, it appears now to be good practice to: a) set up a series of detention pools that are long, shallow, and receive maximum wind exposure. This gives the wastes opportunity for aeration as well as exposure to the sun so that the waters can heat up and promote chemical decomposition; b) separate wastes. Some types of wastes are much more toxic than others. Some of the toxic ones may have small enough outputs so that they can be held in separate ponds.

Chemical treatment of wastes seems to be a valid approach to the disposal of toxic substances, but the actual treatment does not lie within the realm of a biologist. He can only test the effectiveness of such treatment. Satisfactory chemical handling of the refinery wastes is described by Fowler.[2] Walker[3] outlines a treatment to be used for disposal of spent and contaminated soluble oil mixtures.

Now back to the original question: Can refinery wastes be dumped into a stream with minimum damage to the fish life? The answer appears to be yes, provided that there is sufficient dilution and that the discharge of the wastes is geared to the discharge of the receiving waters. Whether this is practical or not depends on whether the stream is large enough to receive all the wastes that must be discharged.

ACKNOWLEDGMENTS

The above phase of pollution studies in Oklahoma was subsidized by the Oklahoma Planning and Resources Board and it is a part of a much larger program now in progress. The authors are grateful for help from the Oklahoma Public Health Department, the U. S. Public Health Service, the U. S. Geological Survey, the Oklahoma Game and Fish Department, the Red River Fisheries, Hugo, Okla., the Fisheries Research Laboratory, Norman, Okla., and the Anderson Pritchard Oil Refinery, Cyril, Okla.

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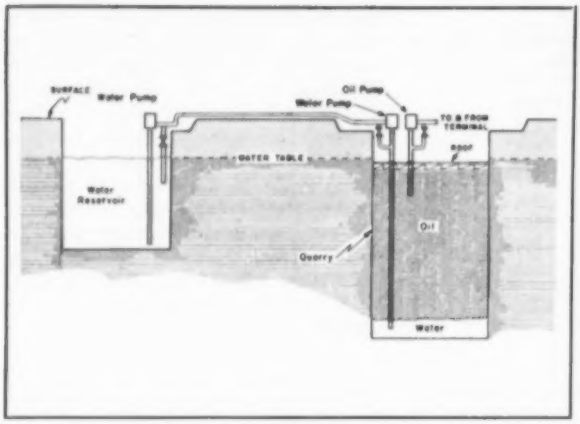

Figure 1. Proposed installation for underground storage of oil, showing pontoon-type roof.

Figure 2. A typical slate quarry which Esso is considering as a seasonal storage reservoir after abandonment.

Esso considering this plan for . . .

Underground Product Storage

ESSO STANDARD Oil Company is considering plans to adapt abandoned slate pits in northeastern Pennsylvania to underground reservoirs for seasonal storage of home-heating oil. By such means additional primary storage of light fuels would be provided near consuming areas, thus easing the peak winter demand burden on transportation and refining facilities.

The company has taken options on 11 slate quarries or pits in the Pen Argyl section near Bethlehem which have a total potential capacity of 13 million barrels of heating oil. The pits range in dimensions from 100 to 300 feet deep, 200 to 500 feet long and 140 to 270 feet wide. Except for suitable protective roofing and other necessary facilities, such as pumps and pipe line connections, the pits with relatively minor engineering can be converted to large storage reservoirs.

This underground storage of refined products would be the first of its kind in the U. S., though previously the principle of underground product storage in abandoned mines has been successful in Sweden.

As is shown in Figure 1, Esso's plan would be similar to that developed by Edholm in that the product in storage would rest on an adjustable water bed and is prevented from leaking out by the surrounding water table. Esso, if its plans are finally approved, would use two abandoned quarries, one as a reservoir and one as the product storage reservoir, at each storage location.

Presently all quarries being considered for heating oil storage are filled with water, and heating oil would be pumped in the top and water pumped from the bottom into the adjacent water storage reservoir. A constant water cushion would be kept on the bottom of the product storage reservoir and the level of the product in storage would be kept below the surrounding water table to prevent leakage of the product through any cracks or fissures. Wells would be drilled around the storage quarries to keep a check on the water table which has a maximum fluctuation in the area under consideration of 20-25 feet.

Erection of a suitable cover for the storage reservoirs would be the biggest cost item. Esso engineers are considering adaption of a floating pontoon roof with sections designed to fit the contour of the quarry or possibly a roof suspended on cables anchored in the overburden.

Initially the company is considering the operation of only one pit which has a capacity of 3 million barrels. This quarry, shown in Figure 2, is 270 feet deep, 350 feet wide and 250 feet long. The capacity of existing pipe lines which may serve it, however, will limit the storage to 1-1.5 million barrels—the practical volume that could be moved into storage from the Bayway, N. J., refinery during the summer months and back to consuming areas in metropolitan New York when needed.

Cost of adapting the pit to storage likely would be $1 million with a year needed to complete the facilities. Esso estimates that steel tankage with necessary pipe line facilities average $2 a barrel while, depending on the cost of the roof, the average quarry storage reservoir will cost from 25 cents to $1 a barrel.

Plans are to use the quarries at present only for heating oil storage, but Esso officials believe any refined product, except residual fuel oil could be satisfactorily stored in the pits. The problems of residual fuel oil storage are those of transporting the material to the inland storage and getting it out, and the fact that the residual would have to be stored over a water base. Use of the underground primary storage in the quarries, however, would open some existing tankage on the seaboard for residual fuel storage.

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Meet Our **Authors**

Eugene Ayres | T. W. Legatski | J. W. Tooke | L. A. Grundy | David Hostedler

Enterprising Period Prominent in **Ayres'** Life

Eugene Ayres, "Liquid Fuels in America," page 90.

One ten-year period stands out in the life of Eugene Ayres. It was a time during which he occupied himself with the development and promotion of new industrial enterprises. It all began soon after he was graduated from Swarthmore College in 1912 with a B.A. degree. During this time, he established the first American manufacture of diphenylamine, wool grease, lanolin, amorphous petroleum wax, and synthetic alcohols from petroleum. He developed the presently used methods of large-scale direct chlorination of petroleum hydrocarbons.

In 1929 he joined Gulf Refining Company as research head. He was transferred in 1934 to Gulf Research & Development Company. Since that time he has been engaged in the organization and management of research concerned with the manufacture and sale of petroleum products.

15-Year Study Behind Papers by **Phillips Trio**

T. W. Legatski, J. W. Tooke and L. A. Grundy, "Approximating Natural Gas Composition," page 105.

In 1935, following five years with Texaco Salt Products Company as a research chemist, James Tooke joined the Research and Development department of Phillips Petroleum Company. There he became associated with Ted Legatski, who was assistant director of research for Phillips. The two soon began a study of relationships existing between the physical properties and compositions of natural gases. The article appearing this month and "Absorption Index," which appeared last month, both prepared in collaboration with Larry Grundy, are the culmination of more than 15 years of study of those relationships.

Legatski joined Phillips as a research engineer in 1925, soon after receiving a degree in chemical engineering from the University of Michigan. In 1929 he was made supervisor of the Burbank Laboratories of the company, and soon was made assistant director of research. In recognition of his many contributions in the field of light hydrocarbon technology, he was awarded the 1952 Natural Gasoline Industry's Hanlon Award.

Tooke, a 1930 graduate of Centenary College, B.S. in chemistry, is presently project supervisor in the Research division. He has been concerned professionally with problems relating to the composition and properties of natural gases and gasolines.

Grundy obtained his chemical education at Baylor University and Oklahoma A & M College. In 1952, after two years as an instructor in chemistry at Clarendon College, Clarendon, Texas, he joined Phillips' Research and Development department. He is presently in the Instrument Development and Applications group of the Chemical Engineering division.

Gadgeteer Regrets Arrangement of Time

David E. Hostedler, "Design and Construction of Control Valves," page 133.

Farms in West Virginia, where he was born, Virginia and Delaware provided the backdrop for this instrument engineer's early home life. No taste for agriculture developed, he departed the homestead to seek a technical education.

Childish inclinations to take apart the family clocks and other mechanical devices were to prove prophetic.

In Philadelphia Hostedler attended Drexel Institute, was graduated as an electrical engineer, specializing in power transmission and transmission line design. When graduation time rolled around, he asked himself a question: "Why not work with fascinating gadgets such as instruments?" He was unable to give himself any suitable answer and so gravitated to the relatively young and interesting instrumentation field.

His first jobs were with Philadelphia Electric Company and Western Electric, after which he spent 13 years with Brown Instrument Company, working in almost all phases of this organization's activities.

Hostedler joined Foster Wheeler Corporation in 1942 and is there today. In charge of the company's instrumentation and control group of the process plants division, he directs the design, specifications and selection of the instruments and automatic control equipment required to operate such processing plants.

Hostedler, married with no children, says his only regret is there aren't enough hours to keep up with instrument engineering and to do a good job at his hobby of surf fishing.

Globe Trio Came By Different Routes

A. C. Dystrup, W. F. Krause and K. A. Buchanan, "Save LTFD Calculation Time with These Sheets," page 115.

By different routes and from different locales these co-authors all arrived at Globe Oil & Refining Company. Dystrup following his graduation from the University of Chicago; Krause after obtaining his Ph.D. degree in chemistry from the University of Wisconsin, and Buchanan after graduation from Canisius College of Buffalo and a four-year stopover as an analytical chemist in the laboratories of the Alco Products division of American Locomotive Company.

Dystrup was born in Lemont, Ill. At the University of Chicago he earned his athletic letter as a quarter miler and, in passing, his B.S. degree in chemistry. At Globe he began as an analytical chemist on the laboratory staff at the company's Lemont refinery. He was promoted to assistant chief chemist in 1940 and to chief chemist last November.

Krause, a Minnesota farm boy, attended Macalester College in St. Paul, majoring in chemistry. Winding up his graduate work at the University of Wisconsin in 1934, he moved to Glove's Lemont refinery as the "one, lone research chemist." Working for Globe wasn't exactly new for Krause as he had worked summers at its various refineries while still in college. He was promoted to chief chemist in 1938 and to technical manager of all chemical and engineering work in November, 1952.

A native of Dunkirk, N. Y., Buchanan received his B.S. degree in 1936. Four years later he was a gas analyst in the Analytical and Development laboratories at Globe's Lemont plant. In 1952 he attended the NGAA sponsored school on low temperature distillation of gases and also a special course on the application techniques of infrared spectroscopy given by Massachusetts Institute of Technology.

All three members of this writing team are married. Dystrup has two sons; Krause, twin sons and a daughter; and Buchanan, two daughters and a son. For relaxation, Dystrup turns to music and sports, Krause to gardening, carpentry and municipal finance and Buchanan to leather working and watch making.

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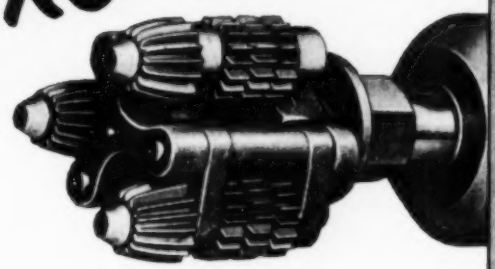

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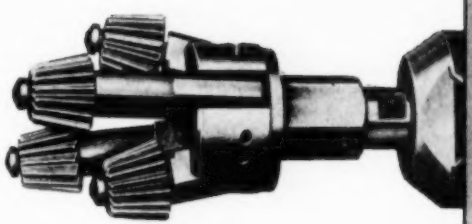

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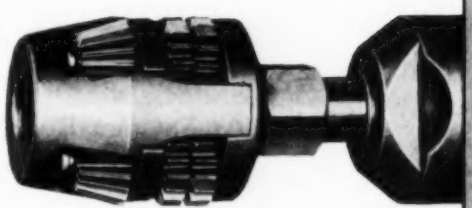

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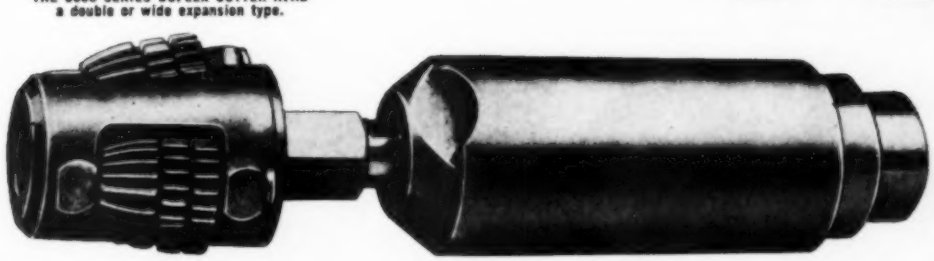

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Meet Our **Authors . . .**

A. C. Dystrup | W. F. Krause | K. A. Buchanan | D. J. Pompeo | D. L. Katz | R. H. Schatz

Mayo Compares Drivers For Fluid Cat Crackers

H. C. Mayo, "Electric Motors Vs. Steam Turbines for FCUU," page 96.

H. C. Mayo was born in Philadelphia, Miss., and was graduated from Mississippi State College in 1940 with a B.S. degree in electrical engineering. For the next two years he was employed by American Cyanamid Company, leaving to enter the U. S. Army. Discharged in 1946, he returned to American Cyanamid as an electrical engineer. He joined The M. W. Kellogg Company in 1948 as assistant chief electrical engineer. He began a training program in August, 1951, and has since worked in the Instrumentation and Equipment divisions.

Li and Lapp Concoct A Tempting Treat

Y. T. Li and P. A. Lapp, "New Flow Meter Measures True Mass Rate, page 119.

Take a pinch of China, add a dash of Canada and mix well at Massachusetts Institute of Technology and you just might come up with as tempting a dish as served up by these co-authors.

In this particular instance the Chinese ingredient would be Yao Tzi Li, who holds a B.S. degree in mechanical engineering from Peiping University and an M.S. degree in aeronautical engineering from National Central University, Nanking.

And of course the Canadian dash would be Philip A. Lapp, who was graduated from the University of Toronto with a B.A. Sc. in engineering physics in 1950 and from M.I.T. with an S.M. degree in automatic control a year later.

Li, who also has an M.S. degree in aeronautical engineering and a Sc.D. in aeronautical engineering from M.I.T., has been a research associate, aeronautical engineering, instrument section, at M.I.T. since 1947. When he returned to China in 1940, he set up a modern aircraft engine factory and, for four years, was chief engineer and production manager there. From 1944 to 1945 he was a professor at the Aeronautical Academy of the Chinese Air Force at Chengtu, and, for the subsequent year, was a professor at Yenching University of Peiping. Leaving Yenching University, he returned to the U. S. and joined M.I.T.

Lapp is presently "in pursuit of Sc.D. in instrumentation" at M.I.T., which he expects to receive this year. He has served as an assistant instructor of aeronautical engineering, instrument section, at M.I.T., and, in 1952, began as an instructor in aeronautical engineering. He recently took a four-month leave from M.I.T. for work with PSC, Applied Research, Ltd.

Senior Chemist Starts As Summer Roughneck

John H. Jordan, Jr., "Determining Tetraethyl Lead in Gasoline by Flame Photometry," page 139.

During Summers between terms at the University of Texas, John Jordan worked as a roughneck. In 1939 he received from the school a degree in chemistry and returned to roughnecking—but only for a short time. He joined Magnolia Petroleum Company in 1940 and he's still there.

In the beginning he did general analytical work. Today, as senior chemist in the products control laboratories, he is engaged in work on analytical methods applied to petroleum problems.

The father of two small girls, he lists his hobbies as glass-blowing and amateur photography.

Katz, Schatz, Williams Form Michigan Threesome

Donald L. Katz, Ralph Schatz and Brymer Williams, "Thermodynamic Data for Low Temperature Design," page 101.

At the University of Michigan, Dr. Katz is a professor of chemical engineering and chairman of the department of chemical and metallurgical engineering, Schatz is a graduate student, working towards his doctorate degree, and Dr. Williams is associate professor of chemical engineering.

Katz was born in Jackson County, Miss., and received his doctorate from the school at which he now teaches. After graduating in 1933 he entered the Research department of Phillips Petroleum Company, returning to the university three years later as assistant professor of chemical engineering. In 1950 he was the recipient of the Natural Gasoline Association of America's Hanlon Award. His hobbies are color photography and travel.

Schatz was born in Columbia, S. C., but now makes his home in Detroit. During the summer of 1952 he was employed by Standard Oil Company (Indiana) at Whiting, Ind. He has been active in the student chapter affairs of AIChE and has been an assistant to Dr. Brymer Williams.

Born in Denver, Williams began his collegiate work at the University of Denver. He received his B.S. degree from the University of Michigan in 1936. He had almost completed work for his doctorate in 1951, when he joined The M. W. Kellogg Company. In 1947 he returned to the University. Upon completion of his doctorate work he became a member of the teaching staff. A photograph of Dr. Williams was unfortunately unavailable at the time of this printing.

Continued on page 214

J. H. Jordan | Y. T. Li | P. A. Lapp | H. P. Glemens | P. Summers | H. Rase

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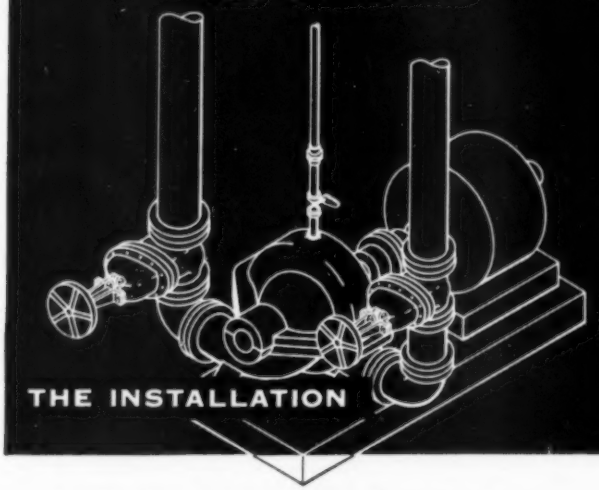

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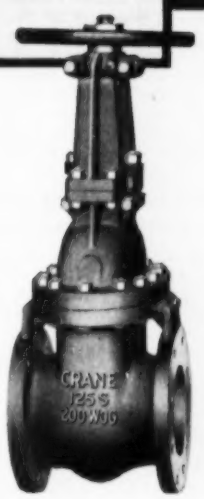

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What's **Happening** in the Industry...

Employes Set Safety Mark—

Representing the 8200 employes of the Whiting, Ind., refinery of Standard Oil Company (Indiana), Robert W. Springer and his father, John, at left in helmets, and A. F. Endres, refinery manager, center, accept National Safety Council's Award of Honor. Ned H. Dearborn, president of the council, presents the council's highest award for industrial accident prevention for the employes' 1952 safety record. In setting the record, the employes cut the accident frequency 68 percent and severity 52 percent, which is below par on experience of both the Whiting plant and the industry as a whole for the previous three years.

OIIC Adds Philip Humphrey To Staff as Deputy Director

Philip C. Humphrey, manager of public relations at The Texas Company for the past 11 years, has joined the staff of the Oil Industry Information Committee of the American Petroleum Institute. He was appointed deputy director, in which post he will be in direct charge of all creative work.

He has been identified with the OIIC program since its inception in 1947 and has served three terms as a vice chairman of the national group. Also, he has served as chairman of the film subcommittee.

New York Air Brake's Sillcox Nominated for ASME President

Nomination of Lewis K. Sillcox, vice chairman of the board of The New York Air Brake Company, for 1954 president of the American Society of Mechanical Engineers has been announced. Sillcox heads a slate which includes a number of the society's present officers. As only one name is submitted by the society's nominating committee, nomination is practically the same as election.

Du Pont Survey Shows Drop in Regular-Grade Gasoline Octane

While refiners have focused their attention on pushing higher octanes of premium-grade gasoline, octane ratings of regular-grade gasoline have slipped to about what they were in October, 1952. The drop in octane ratings of regular is reported in the July, 1953, survey of 50 U.S. and Canadian cities conducted by the Petroleum Chemicals division of E. I du Pont de Nemours & Company.

The number of cities having average octanes of 85 or better for regular dropped considerably since Du Pont's last quarterly survey in April. Highest octane regular-grade was shared by Boston, Cleveland and Philadelphia, with an average of 87.7, compared with a high 88.0 last April in Baltimore.

The number of cities having premium-grade of 90 octane or better increased by three from 36 in April to 39 in July. Milwaukee had the highest average with 93.5, compared with a high of 92.9 for Boston last April.

Frank Porter Hits Claims of Excessive Stocks in Industry

Claims before the House Commerce Committee in Washington that industry's inventories are excessive and substantially above those of last year have been challenged by API President Frank M. Porter.

Inventories were reduced to almost dangerously low levels by strikes of May, 1952, Porter said. "Therefore," he added, "to compare today's level of refined inventories with those of one year ago and say they are much, much higher is literally a true statement in one sense, but in actuality is only a half-truth."

Porter said that a much fairer comparison of current inventories would be between a pre-strike 1952 date and a corresponding date for 1953. If this is done, he said, the following comparisons are revealed:

Crude oil days' supply available in storage: 1952—13.0 days, 1953—14.4 days; clean products 1952—28.1 days, 1953—27.7 days; residual fuel oil: 1952—12.9 days, 1953—13.9 days.

This makes it "immediately obvious that the increase in inventories is very moderate, and that by no stretch of the imagination could (they) be called excessive," Porter insisted.

Record Set by Platformer at Johnson's Oklahoma Refinery

A Platformer at Johnson Oil Refinery Company's Cleveland, Okla., refinery has set a world's record by operating on its initial catalyst charge since it went on stream June 21, 1951. Licensed by Universal Oil Products Company, the unit has operated 97.6 percent of the time the refinery has been in operation during the two-year period.

At the end of its second year of operation, the Platformer had processed 1,050,000 barrels a day of charge and produced 971,500 barrels of platformate. The unit has also charged more than 167 barrels of reactor charge for each pound of the original catalyst.

Refining Center Look—

General Petroleum Corporation's plans for a new $35 million refinery at Ferndale, Wash., are inspected above, from the left, by B. Brewster Jennings, president of Socony-Vacuum Oil Company, Inc.; R. L. Minckler, president of General Petroleum; and S. D. Bechtel, president of Bechtel Corporation. The proposed 35,000-barrel-a-day refinery is another of the major petroleum processing plants which are springing up in that area, underscoring *Petroleum Refiner's* earlier (April, 1953, p. 87) observation that the Pacific Northwest is shaping up as an important refining center.

The plant, now being designed and constructed by Bechtel, will process crude oil from Alberta fields, brought to the Pacific Coast by the Trans Mountain Oil Pipe Line.

Survey Expects Doubling of Cracking Catalysts by 1955

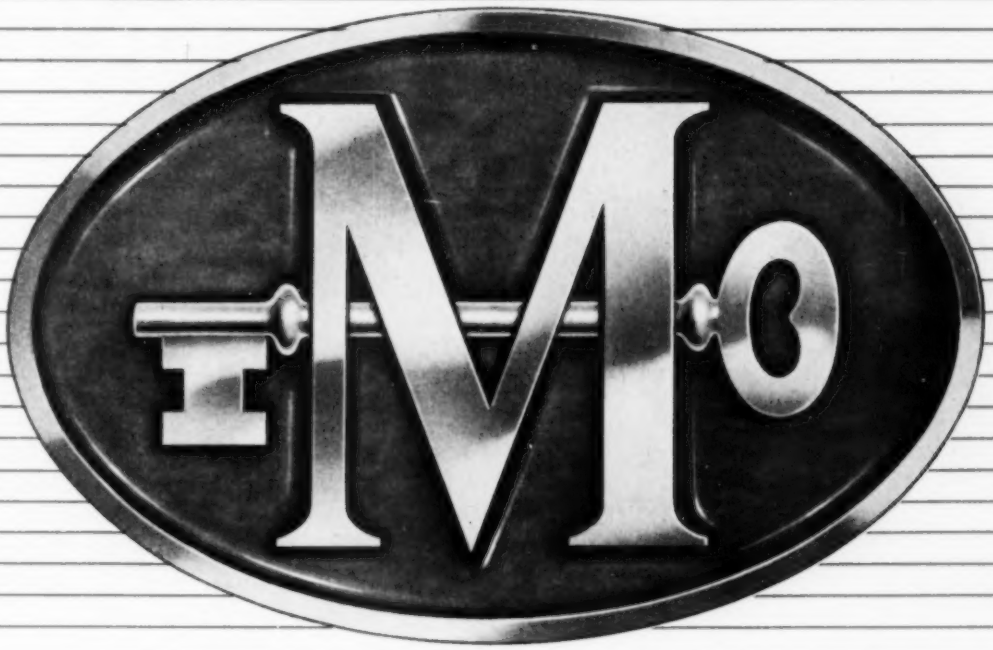
Consumption of catalysts in catalytic cracking operations of the U. S. and free-world petroleum refineries is expected almost to double by January, 1955, the 1952 consumption, according to an industry survey just completed by PAD.

Despite the projected increase in consumption, a PAD official said, the supply of catalysts, of both fluid and pellet types, is expected to be substantially equal to the requirements estimated for the beginning of 1955. Nevertheless, the official said, additional expansion to provide more capacity for manufacturing both types of catalysts may prove to be desirable as a reserve for wartime emergency.

The survey projects an increase of 72 percent between 1951 and 1955 in installed fluid cracking capacity in the U. S. and friendly foreign countries and an increase of 66 percent in installed moving-bed cracking capacity over the same period.

University of Illinois to Give Cathodic Protection Course

A short course on cathodic protection will be given October 12-16 by the University of Illinois, Urbana, on its campus in cooperation with the National



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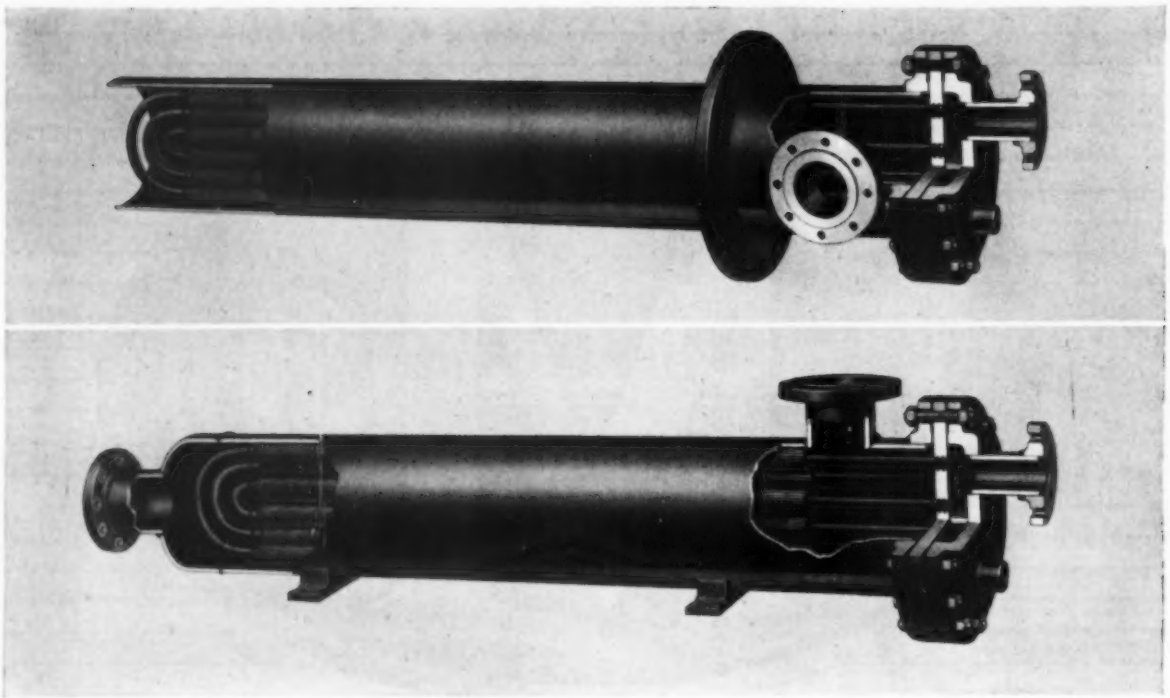

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Tank Suction Heaters and Line Heaters

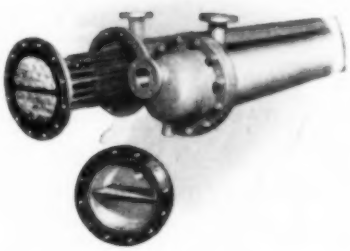
Offer Many Outstanding Advantages

Brown welded fintubes provide much greater heating surface per foot of length than plain bare pipe or tubing. Consequently these heaters transfer more heat — at lower temperatures — assuring **faster, more efficient** heating without damaging the material or causing coking and build-up on the heating surface.

Metal bands placed around alternate fintubes in the bundle prevent the tubes from interlocking. This eliminates baffles and tube spacers that create back eddies and stagnant areas that encourage fouling;—and permits the fluid to travel through the longitudinal passages of the fintubes in close contact with the fins and center tubes — at low pressure drop.

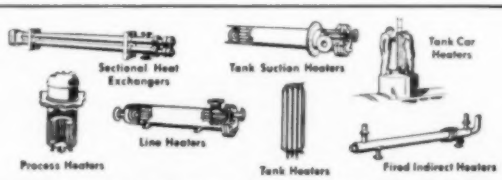
Tank Suction Heaters that mount on a tank nozzle or the tank shell — also Line Heaters for pressure or suction service. Sizes 5″ to 24″ in diameter and 4′ to 24′ in length. Send for Bulletin No. 521. It gives full details.

Brown Fintube Hairpin Bundles Showing the Banding of Alternate Tubes that Eliminates Baffles and Assures Unobstructed Flow.



Hairpin Bundle Assembled in Shell Showing Mounting of Tube Sheet Between the Shell and Head.

BROWN FINTUBE CO.
Elyria, Ohio



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What's **Happening** . . .

Association of Corrosion Engineers. All instructors for the course are members of NACE. Professor Ray Wainwright of the Univerity's electrical engineering staff is coordinator.

The sessions will cover practical information useful to operating and engineering personnel. Registration information may be obtained from Professor R. K. Newton, 713½ South Wright Street, Campaign, Ill.

Two at General Petroleum Get Executive Posts at Ferndale

Two executive appointments for its new Ferndale, Wash., refinery have been announced by General Petroleum

Cortelyou

Stanich

Corporation. Named manager of the plant, which is now under construction, was Curtis G. Cortelyou. V. M. Stanich was appointed chief engineer.

In his new post Cortelyou succeeds R. E. Lauterbach, recently promoted to manager of General Petroleum's Manufacturing department. He has been with General Petroleum since 1938. In 1943 he was assigned to the Engineering department and, since that time, has been job engineer, project engineer and chief design engineer.

Stanich joined the corporation in 1937 in laboratory work and has since served as a lubrication engineer, a chemical engineer and a refinery engineer.

CNGA Installs New Officers; Hartley Elected President

Fred L. Hartley, general superintendent of operations, Union Oil Company of California, was installed last month as president of the California Natural Gasoline Association. A. C. Lyles, chief gas engineer, General Petroleum Corporation, was elected vice president, and E. R. Millett, Jr., was reappointed secretary-treasurer.

Following his election, Hartley appointed D. R. Arnold, Superior Oil, general chairman of the association's 28th Annual Fall Meeting to be held October 8 and 9 at the Ambassador Hotel, Los Angeles.

Serving on the committee to handle arrangements for the meeting will be:

S. A. Bradfield, Southern California Gas Company; M. W. Kibre, General Petroleum Corporation; Paul Magee, The Ohio Oil Company; Wm. R. Runbeck, Guy T. Martin Company; R. W. Todd, Pacific Lighting Gas Supply Company; E. W. Walker, Western Gulf Oil Company; and Robert Williamson, The Cooper-Bessemer Corporation.

Committee chairmen to serve during the next fiscal year include:

Lyles, Advisory; L. V. Cassaday, Lomita Gasoline Company, Awards; Geo. C. McLaren, Standard Oil Company, Education; Fred Carter, Carter-Jones Company, Entertainment; D. R. Arnold, The Superior Oil Company,

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CUTS PRESSURE FLUCTUATION CHANGES IN HALF

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A NEW DEVELOPMENT OF DESIGN AVAILABLE IN ALL N.G.E. *Wilgus* REGULATING VALVES for steam, liquids or gas

Magna-Stroke is a gear train working at a ratio of 2:1 giving twice the stroke at the inner valve as at the diaphram.

For Process Men Everywhere Who Want Better Control

Through the use of Magna-Stroke action double efficiency is received from regulating valves. Any increase or decrease in pressure to be secured by the opening and closing of the inner valve is done so at a ratio of two to one, since the action of the diaphram is doubled at the inner valve.

Liquid or vapors which are to be maintained automatically at a desired pressure within a close limit can be maintained at half the variation due to Magna-Stroke action of doubling the pressure effect.

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For example, if 30 seconds of time is required to actuate the valve, by pressure or temperature changes in the system, the Magna-Stroke valve will in turn respond in half the time, or 15 seconds.

Bonus Qualities Of N. G. E. Wilgus Regulating Valves Equipped With Thomas Magna-Stroke Action

Valves have smaller diaphragms thus effecting better control. When Magna-Stroke action is reversed, double the power is achieved. Just one more improvement of design which makes N. G. E. Wilgus Regulating Valves the leaders of the industry.

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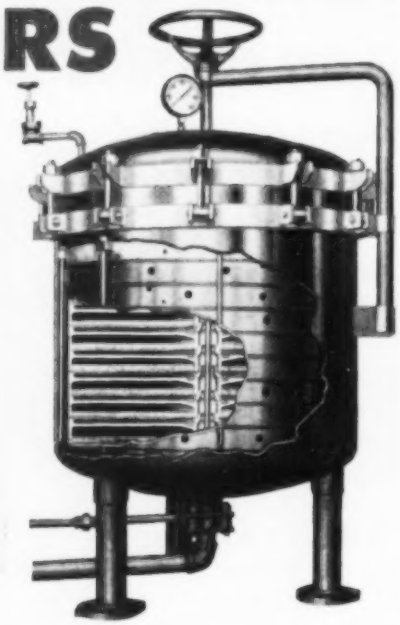
HORIZONTAL PLATE
FILTERS

Noted for High Quality, Consistently Uniform, Fine Sharp Filtration of Petroleum Products....



Many times Sparkler filters have been chosen by experienced filtration engineers in the petroleum field because of these specific features of superiority.

Sparkler filters deliver unusually high flow rates due to the horizontal plate construction that requires only a very thin precoat to produce fine sharp filtration right from the start. Less pressure is required with a thin precoat resulting in a filter cake of less density and high flow capacity. Intermittent operation or variation in pressures will not disturb the stability of the filter cake.

Any grade of filter paper, cloth, or screens, and any filter aid can be used with maximum efficiency because no pressure is required to hold the filter cake on the plate.

Frequently Sparkler filters are used in the petroleum industry with various grades of paper only without filter aid to perform a specific job that would be difficult or impossible with some other types of filters such as the removal of water from diesel lube oil or transformer oil.

A few typical applications of Sparkler Filters to the Petroleum and petro-chemical industries for the filtration of:

- Canned lubricating oil
- Methyl-Ethyl-ketone
- Polyisobutane
- Chlorinated hydro-carbons (carbon tet.)
- Aviation gasoline
- Jet engine fuel
- Hydraulic oil
- Gas engine & diesel lubricating oil (both continuous recirculation on the engine and batch-wise)
- Diesel fuel oil
- Cooling tower water
- Plant effluent water (to obviate stream and lake pollution)
- Removal of Raney nickel from alcohol streams
- Insecticides
- Caustics & acids
- Cottrell precipitator insulating oil (carbon black plants)

Sparkler horizontal plate filters are available in capacities from 30 to 30,000 G.P.H. depending on type of product filtered. Can be supplied in carbon steel, stainless steel, pure nickel, or monel, bronze, Hastelloy and Inconel. Rubber lined, brine or steam jacketed.

Sparkler representatives for personal engineering service are located in Dallas, Houston, San Francisco, and other principal cities. Western Branch, Los Angeles, California.

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MAKERS OF INDUSTRIAL FILTERS FOR OVER A QUARTER OF A CENTURY

What's **Happening** . . .

Fall Meeting: M. L. Fort, Pacific Lighting Gas Supply Company, Finance and Budget; Fred C. Brunner, C. F. Braun & Company, Program; E. R. Millett, Jr., Publicity; J. H. Watson, Union Oil Company, Technical; and M. L. Arnold, Richfield Oil Corporation, Technical Advisory.

Newly elected directors for the two year term 1953-1955 are:

D. R. Arnold, Superior Oil; C. L. Case, Continental Oil Company; F. J. Colton, Tide Water Associated Oil Company; E. C. Cunningham, Wilmington Gasoline Company; J. R. Fluor, The Fluor Corporation, Ltd.; M. L. Fort, Pacific Lighting Gas Supply; C. D. Gard, Union Oil; R. W. Heath, Signal Oil & Gas Company; A. K. Hegeman, Clark Bros. Company; J. C. Herron, Shell Oil Company; Basil Kantzer, Union Oil Company; Wm. A. Kirk, California Southern Oil Company; W. H. Kraft, Honolulu Oil Corporation; Grove Lawrence, Southern California Gas; L. V. Leonard, Shell Oil Company; S. F. Magor, Superior Oil; P. S. Magruder, General Petroleum; F. M. Perry, Cities Service; C. M. Sandland, C. F. Braun & Company; J. A. Smith, The Texas Company; R. W. Todd, Pacific Lighting Gas Supply Company; E. W. Walker, Western Gulf Oil Company and L. M. Windle, Richfield Oil.

Horner Appointed to Succeed Woods as Shell Oil Secretary

Shell Oil Company has appointed J. A. Horner to succeed F. W. Woods, retired, as secretary of the company. Horner was formerly administrative assistant to the president and assistant secretary.

Horner

Born in Oklahoma City, Horner joined Shell as an attorney at Tulsa in 1936. He later served at Centralia, Ill., and New York.

Woods joined Shell in 1920 as a chief accountant in Tulsa. He also served at St. Louis and Houston before going to New York in 1934. In 1940 he was appointed secretary.

Monsanto Plans Construction Of New Research Laboratory

Immediate construction of a four-story engineering research laboratory at its Nitro, W. Va., plant has been planned by Monsanto Chemical Company. The 60-by-85-foot structure, expected to be completed by mid-1954, follows closely the completion last year of additional research laboratory facilities at Monsanto's Nitro location.

The new building will house various items of equipment for process development and engineering research, as well as offices and storage facilities.

Texas A & M Schedules Course On Corrosion in September

A four-day short course on corrosion will be given at Texas A & M College September 22-25, inclusive. Sessions will open Tuesday, September 22, and close noon, Friday, September 25.

The tentative program calls for sessions on corrosion fundamentals, materials of construction, coatings, cathodic protection, instrumentation and special topics. Additional information may be obtained from J. D. Lindsay, Chemical Engineering department, A & M College of Texas, College Station.

What's **Happening** . . .

Refining Vet Joins Suntide As Refining Operations Head

Suntide Refining Company has appointed Herman G. Gunter vice president - Refining Operations.

Gunter

A veteran of 23 years' refining experience, Gunter has served in many capacities throughout the industry. He began his career with Standard Oil Company (New Jersey) in 1930 as an analyst in the chemical laboratory of its Baltimore refinery. From 1947 to 1952 he was assistant to the vice president of The Carter Oil Company. In August of last year he became assistant general superintendent of Continental Oil Company at Ponca City, Okla.

B-A Starts Construction of Vancouver Office Building

Construction has started on a new office building of The British American Oil Company Limited in Vancouver. The spacious building will house the company's Pacific Coast regional offices and the British Columbia sales office. Completion of the two-story structure is planned for April, 1954.

The building will have fluorescent lighting, fully automatic convector-radiation oil heating, covered parking for customers and acoustically treated walls and ceilings. Plans provide for two additional stories at a later date. Commonwealth Construction Company Limited is the contractor.

Two Promoted in Changes Made At Humble Baytown Refinery

Two promotions and several staff additions have been announced for Humble Oil & Refining Company's Baytown, Texas, refinery.

In the Research and Development division, George R. L. Shepherd has been promoted to senior research chemist. His duties will range from the fundamental study of catalytic conversion processes to the preparation of economics for proposed new processes.

In the Refining department, Jack W. Smalling has been promoted to assistant general foreman of light ends. He was formerly a member of the Technical Service division.

Staff additions announced were:

Adrian D. Bolch, Jr., B.S. degree in mechanical engineering, Georgia Schol of Technology; James D. Tatum, B.S. degree in mechanical engineering, Alabama Polytechnic Institute; and Wm. R. Taylor, B.S. degree in civil engineering, Mississippi State College, to Maintenance department of Engineering division.

Delos E. Bown, Ph.D. degree in physical organic chemistry, Massachusetts Institute of Technology; and Thos. S. Farmer, M.S. degree in chemical engineering, Princeton University, to Research and Development division.

Ronald L. Anderson, B.E. degree in chemical engineering, Vanderbilt; Wm. H. Dickerson, B.S. degree in chemical engineering, Virginia Polytechnic Institute; J. Irwin Jordan, Jr., B.S. degree in chemical engineering, Texas A & M; and Robt. Seidomridge, B.S. degree in chemical engineering, Georgia School of Technology, to Technical Service division.

Thos. H. Royder, B.S. degree in chemical

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OPENS THE DOOR

TO MORE DEPENDABLE ANNUNCIATOR PERFORMANCE

WITH NEW "INSTRUMENT-TYPE" CONSTRUCTION

LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for *long term* dependability and service. Built to match the responsibility an annunciator must assume in your plant.

The PANALARM "50" Cabinet has a substantial hinged door . . . with sub-door to allow easy access to signal lamps. It has a new, rugged chassis design . . . pre-wired to handle any standard audio-visual signal requirement . . . and so flexible that signal sequences can be changed by simple terminal connections. No re-wiring is needed.

All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.

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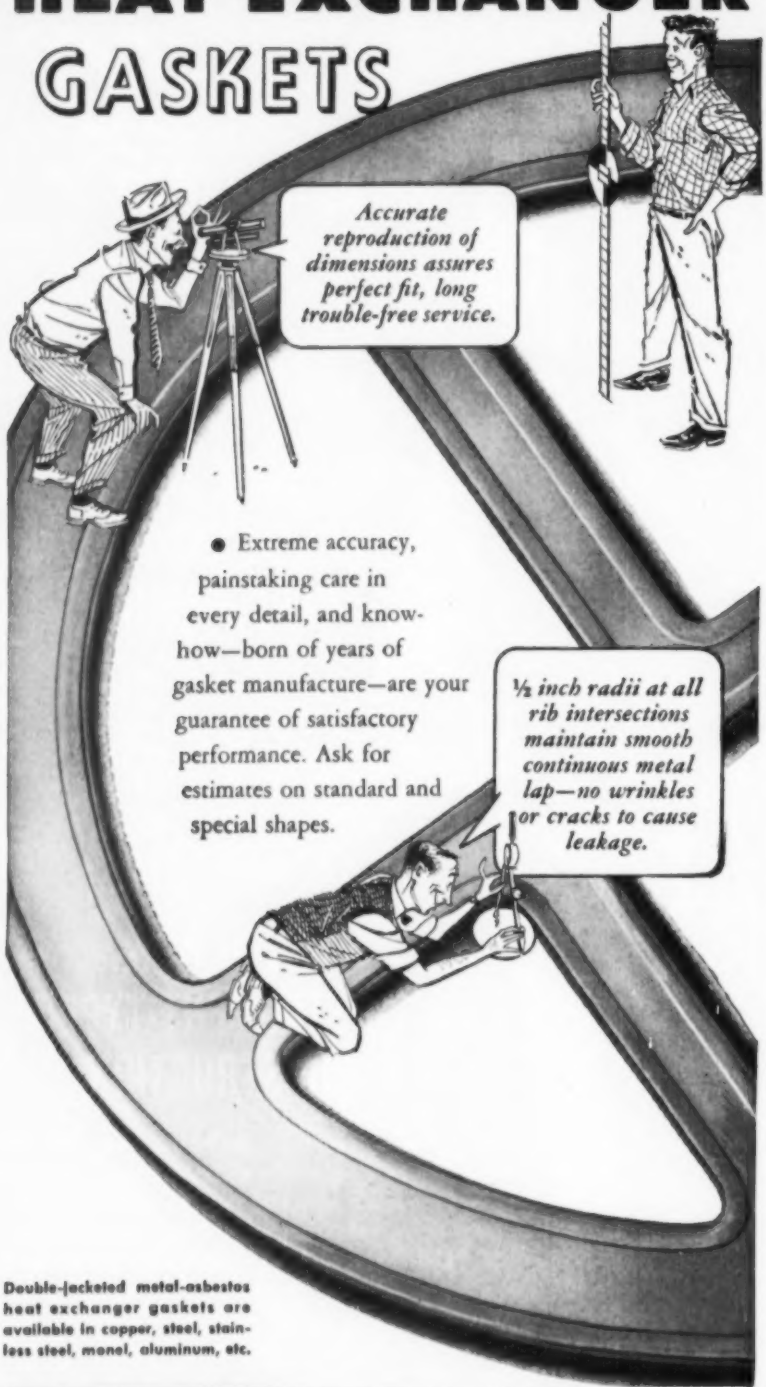
HEAT EXCHANGER GASKETS


Accurate reproduction of dimensions assures perfect fit, long trouble-free service.
½ inch radii at all rib intersections maintain smooth continuous metal lap—no wrinkles or cracks to cause leakage.

● Extreme accuracy, painstaking care in every detail, and know-how—born of years of gasket manufacture—are your guarantee of satisfactory performance. Ask for estimates on standard and special shapes.

Double-jacketed metal-asbestos heat exchanger gaskets are available in copper, steel, stainless steel, monel, aluminum, etc.

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FABRICATORS OF FLUOROCARBON AND OTHER PLASTICS

Representatives in Principal Cities Throughout the World

What's **Happening** . . .

engineering, Texas A. & M., reemployed on the staff of Technical Service division after almost two years in the U. S. Army.

Nyotex Promotes Mitchell To Executive Vice President

C. W. Mitchell has been appointed executive vice president of Nyotex Chemical Company, Houston, jointly owned subsidiary of Consolidated Chemical Industries, Inc., Stauffer Chemical Company and Harshaw Chemical Company.

Mitchell

Mitchell has been with Consolidated Chemical for 24 years and has 17 years experience with Missouri Pacific Railroad. He was vice president of Nyotex prior to his appointment. Nyotex Chemical manufactures aluminum chloride, hydrofluoric acid and lime.

New Materials Specifications Accepted at ASTM Meeting

Seventy-two of the American Society of Testing Materials' technical committees reported at the society's 1953 Annual Meeting held June 28 through July 3 at Atlantic City. As a result of the reports, 63 new specifications and tests were approved. All of these new tentatives will be published later in the year in the 1953 Supplement to the Book of ASTM Standards.

Included in the new specifications were the following on petroleum products and lubricants:

Methods of—

Test for Effect of Grease on Copper (D 1261-53 T).

Test for Lead in New and Used Greases (D 1262-53 T).

Test for Leakage Tendencies of Automotive Wheel Bearing Grease (D 1263-53T).

Test for Water Washout Characteristics of Lubricating Greases (D 1264-53T).

Sampling Liquefied Petroleum Gas (D 1265-53 T). (Jointly with Committee D-3).

Test for Sulfur in Petroleum Products and Liquefied Petroleum Gases by the Co_2-O_2 Lamp Method (D 1266-53T).

Test for Vapor Pressure of Liquefied Petroleum Gas (D 1267-53 T).

Test for Unsaturated Light Hydrocarbons (Silver-Mercuric Nitrate Adsorption) (D 1268-53 T).

Test for Polarographic Determination of Tetraethyl lead in Gasoline (D 1269-53T).

Humble Division Promotes Pfennig to Research Specialist

Promotion of Reuben F. Pfennig to research specialist at the Baytown, Texas, refinery has been announced by the Research & Development division of Humble Oil & Refining Company. Since he joined Humble in 1933, Pfennig has worked in various phases of research on distillation, extractive distillation, solvent extraction, crystallization, polymerization and dehydrogenation processes. In

Gone for good!

There's nothing quite as lost as profits that go up in smoke! We mean the profits from the valuable dust that's mixed with the smoke from many industrial stacks.

Alert Plant Engineers, seeking the most economical way to recover that dust, come to Buell.

Why? Because, for more than twenty years, Buell Engineers have specialized in this field. Their objective: better and more economical equipment. Their success: case histories that show the recovery of more than 40 tons of valuable dust *daily*.

To accomplish this, Buell Engineers analyze dust content in *advance*—can tell you the most economical way to reclaim its value.

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Larkin also furnishes Swage Nipples and Bull Plugs made from SAE 8620 (Refinery Alloy Steel) in sizes from ⅛" through 2".

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What's **Happening** . . .

his new position he will specialize in the development and evaluation of processes for the manufacture of petrochemicals.

General Petroleum Appoints Simpson to Manufacturing Post

Thomas P. Simpson has been named assistant director of manufacturing of General Petroleum Corporation.

Simpson

Soon after joining General Petroleum in 1924, Simpson was transferred to Socony-Vacuum Oil Company, Inc., of which General Petroleum is Western affiliate, as chief development engineer of the Socony-Vacuum laboratories.

Since 1947 he has been director of Socony-Vacuum's Research and Development laboratories, with headquarters at Paulsboro, N. J.

Arthur G. McKee Elects Two With Retirement of Haven

William A. Haven has retired as a vice president of Arthur G. McKee & Company. A vice president of the company for the past 25 years, he has recently been in charge of the Metals division. He will continue as a director of the company and as a consultant.

As a result of the retirement, the company's board of directors elected Merrill Cox vice president, Metals division, administration and sales, and A. L. Foell vice president, Metals division, in charge of engineering. Both have been with the company 24 years.

UOP and London Concern Form Catalyst Manufacturing Firm

Universal Oil Products Company has formed a new foreign catalyst manufacturing subsidiary in conjunction with Johnson, Matthey & Company, Ltd., London, England, platinum refiners.

The new firm is Universal-Matthey Products, Ltd., with headquarters in London. It will make available in the sterling market UOP Platforming catalyst for use by refineries in producing premium quality gasoline.

Construction of the new plant to manufacture Platforming catalyst will start right away in England. Procon (Great Britain), Ltd., will build the plant, which is expected to go into production in mid-1954.

Catalytic Construction Gets New Assistant to President

Anson W. Krickl, formerly with E. B. Badger & Sons Company, and later with Stone & Webster Engineering Corporation, has been appointed assistant to the president of Catalytic Construction Company. His principal duties will be in connection with new business development.

Conoco Promotes Boone to Baltimore Resident Engineer

William F. Boone, Ponca City, Okla., division engineer at Continental Oil

EFFICIENT, FAST, PROFITABLE PROCESSING for every batch!

Patterson

PROCESSING EQUIPMENT

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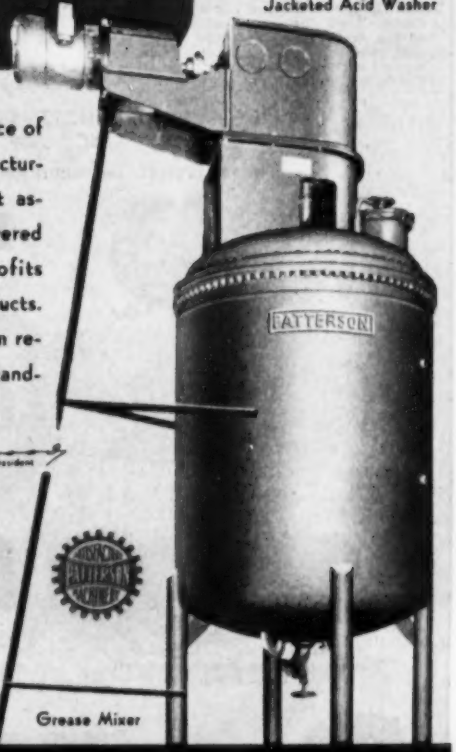
• Reflecting the experience of nearly 90 years of manufacturing, Patterson Equipment assures profits through lowered processing costs . . . profits through improved end-products. Available for the petroleum refiner is a wide range of standard equipment.

Richard L. Conway
President



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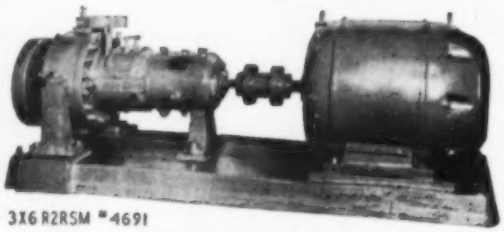
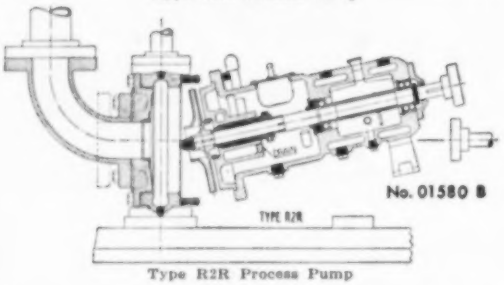
Type R2R Centrifugal Process Pumps



3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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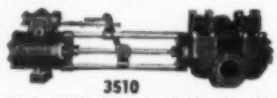
CENTRIFUGAL and RECIPROCATING PUMPS

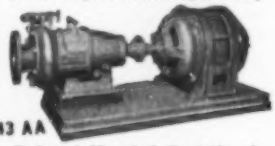
4040H

Close Coupled Centrifugal Pump



3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

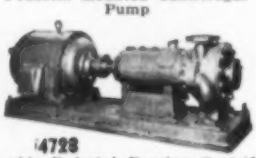


4043 AA

Pedestal Mounted Centrifugal Pump

3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump

3556

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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What's **Happening** . . .

Company's Ponca City refinery, has been promoted to resident engineer at the company's Baltimore petrochemical plant. Since he joined Conoco at Ponca City, Boone has held a succession of refinery posts. He was promoted to division engineer in 1950.

Van Zandt Tops Appointments At New Lion Oil Chemical Plant

Roscoe L. Van Zandt has been named superintendent of the Barton Plant, Lion Oil Company's new chemical plant near New Orleans. Others assigned to management positions at the plant include Stanley B. Johnson, assistant superintendent; John L. Ricks, chief engineer; H. Leon Payton, operating superintendent; Fred B. Elliott, maintenance superintendent; Malcolm C. Lowe, chief chemist; Cary E. Ashley, personnel manager; and Dewey Blackwood, safety engineer.

Van Zandt

All eight of the new appointees have been transferred from the company's headquarters at El Dorado, Ark. Payton and Lowe are at present in New York as Lion's representatives, working with the architect-engineers who are designing the plant.

Van Zandt had six years' experience with other oil companies before joining Lion in 1938 at the El Dorado refinery. In 1942 he became production manager of the chemical plant at El Dorado, later advancing to assistant superintendent of the plant.

Catalytic Construction Names Gains to Engineering Post

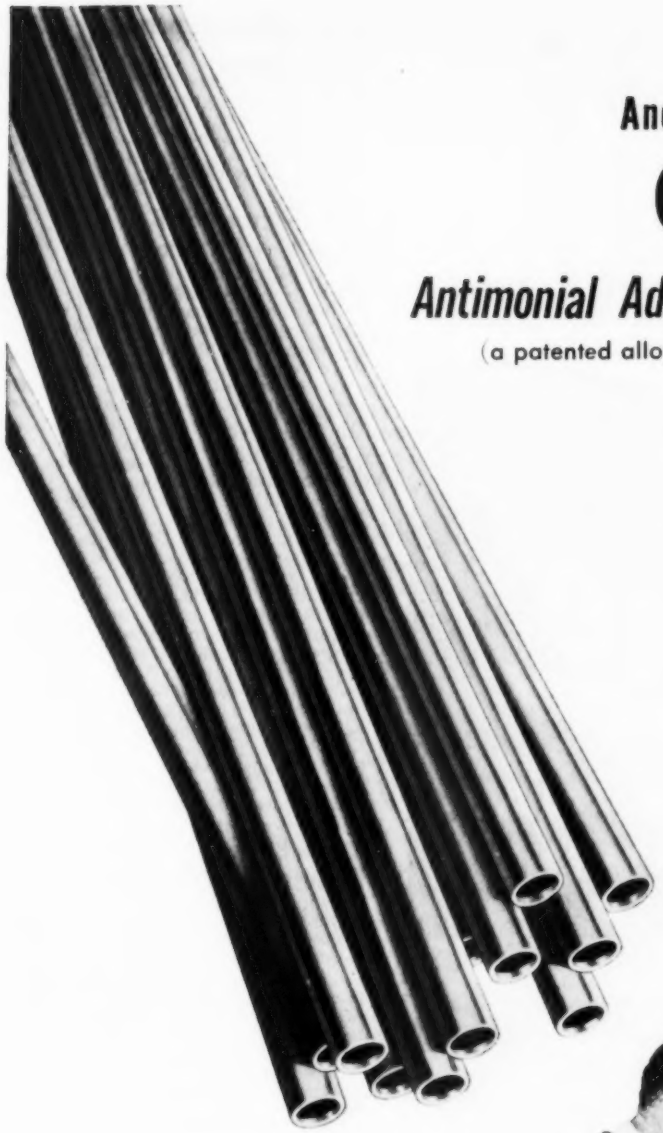
Appointment of Wilfred Gains as assistant to W. E. Kelley, vice president in charge of engineering, has been announced by Catalytic Construction Company. For 12 years Gains was associated with Chemical Construction Corporation as a senior chemical engineer in charge of the design, construction and operation of ammonia and other petrochemical plants. More recently he was a senior project engineer with Vulcan Copper and Supply Company.

Socony-Vacuum Makes Changes In Research and Development

Personnel changes in its Research and Development department have been announced by Socony-Vacuum Oil Company, Inc. T. A. Petry has become a supervisor in the Development division; H. E. Rasmussen was named assistant supervisor of the Refining section; D. P. Heath has become assistant supervisor of the Fuel and Lubricants section; R. R. Halik and L. M. Browning have been assigned to the Process Development section as research associates.

Chemurgic Process Corporation Elects H. B. Larner President

Herbert B. Larner, formerly of the M. W. Kellogg Company, has been



Another reason why

Chase

Antimonial Admiralty Tubes last longer!*

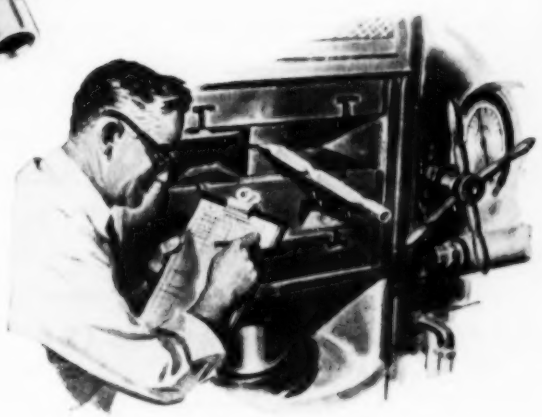
(a patented alloy)

Yes, you can *count* on Chase Antimonial Admiralty Heat Exchanger Tubes to give you many years of satisfactory service.

Chase Heat Exchanger Tubes are rigidly controlled for quality during manufacture, and various tests are applied when the tube is finished. The flattening test mentioned below is a good example. Wall thickness, diameter, surface finish, concentricity and accuracy of length are carefully determined.

So, for Heat Exchanger tubes that last and last, *remember:* insist on Chase Antimonial Admiralty!

*U.S. Pat. No. 2,061,921



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This Chase technician is performing a "flattening test" which is an indication of soundness and freedom from hidden defects. You are assured that tubes passing this test will satisfactorily withstand bending or end flaring.

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Pyrene* has extinguished more major oil fires throughout the world than any other air foam equipment. This is an earned reputation that you can rely on in considering your own protection. Pyrene can provide you with a built-in air foam system or portable equipment that precisely meets your requirements no matter where or what your fire hazard is. For complete information, or the help of a Pyrene engineer, write us today.

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Affiliated with C-O-Two Fire Equipment Co.

The Pyrene Company Limited, England Pyrene Manufacturing Co. of Canada Limited

What's **Happening** . . .

elected president of Chemurgic Process Corporation, College Point, Long Island, N. Y. At Kellogg he initiated the program of research and pilot plant development that produced the Solexol process. He has also been associated with S. B. Penick & Company.

R. R. Jackson and P. E. Kuhl Given New PAD Positions

R. Rea Jackson, director of the Refining and Gasoline division of the Petroleum Administration for Defense since last February, has been named assistant deputy administrator in charge of domestic petroleum operations.

Paul E. Kuhl, director of PAD's Foreign Refining division, will also head the Refining Natural Gasoline division.

Both Jackson and Kuhl joined PAD last January. Both are serving without government compensation.

From 1923 until he went to PAD, Jackson worked for Socony-Vacuum Oil Company, Inc. In 1950 he was named a member of the company's manufacturing committee, which supervises and coordinates refining operations.

Kuhl has worked in the petroleum industry since 1926, beginning as a student engineer with Standard Oil Company (New Jersey). After serving as assistant coordinator of refining for Standard during 1948 and 1949, he was named assistant general manager of the East Coast division of Esso Standard Oil Company, and, in November, 1950, he became assistant general manager of manufacturing for Esso Standard.

Mines Bureau, Oil Officials Discuss Synthetic Fuels Plan

Representatives of ten oil companies and officials of the Bureau of Mines agreed at a recent meeting that continued research in oil-from-shale was a proper sphere for government activity and that development should be left to private industry. The Bureau had called the meeting to outline its proposed program in oil shale and to get oil industry's comments.

The Bureau is planning to continue fundamental research work at its laboratory at Laramie, Wyo., and will concentrate on retorting at Rifle, Colo.

Davis Resigns from PAD Post; Named by McKay as Consultant

Resignation of C. E. Davis as associate deputy administrator of the Petroleum Administration for Defense has been accepted by Secretary of the Interior Douglas McKay. Davis was subsequently appointely by McKay a consultant to PAD.

Davis returns to private industry after 23 months of service in the agency. Joining PAD on August 1, 1951, as deputy director of the Refining division, he was named director of the division on September 3, 1951. He became associate deputy administrator in February, 1953.

Chemical Industry Veteran Dies After 40-Year Career

Dr. Alphons Otto Jaeger, 40-year veteran of the chemical industry, died recently at 67. Since 1929 he has been with American Cyanamid Company, which

PUMPS

for FLUID POWER

in equipment and vehicles required for modern exploration, drilling, production, piping and refining of petroleum. Here is a most comprehensive range of sizes, types, capacities and pressures from 0 to 1500, 2000 and 3000 psi together with hydraulic motors, valves and cylinders for developing complete hydraulic circuits. Here is power which combines safety, flexibility, limitless variations and sound economy . . . hydraulic power at its best.

for HANDLING LIQUIDS

Virtually "any substance that will flow through a pipe," including petroleum products from naphthas to crudes and acid sludge, can be efficiently and economically handled in small or bulk quantities by Pumps available from this single source. There are deep and shallow well Centrifugal and Turbine Types, Rotating Plunger and Herringbone Pumps embracing a very broad range of types, sizes and constructions.

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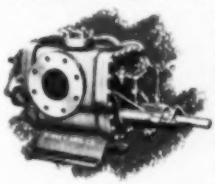
High vacuum pumps for laboratory or high production service in research, vacuum distillation, refrigeration, dehydration, chemical processing, de-aerating, etc.

HYDRECO GEAR TYPE PUMPS

Reversible and non-reversible. Gear type pumps in exclusive FOUR-BOLT design . . . capacities from .5 to 130 gpm and operating pressures to 1500 psi . . . flange or foot mounted . . . furnished with keyed shaft with spline shafts optional. Also dual and tandem models.

KINNEY LIQUID HANDLING PUMPS

A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids, sludges, slurries or viscous substances. Available in plain or steam jacketed models and built of special corrosion resistant metals where desired.



KINNEY VACUUM PUMPS

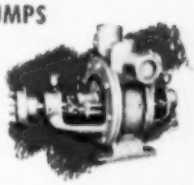
Single stage models to produce absolute pressure readings of 10 microns (.01 mm Hg.) . . . compound pumps producing readings of .2 microns (.0002 mm Hg.) or better. These Kinney High Vacuum Pumps are available in sizes for laboratory as well as high production use.

DUDCO DUAL VANE TYPE PUMPS

DUDCO Pumps provide a broad range of sizes with capacities to 120 gpm and pressures to 2000 psi. Also available in multiple units operating from a single drive. Hydraulic motors with starting torque outputs to 14,000 lb. in. at 2000 psi.

AURORA CENTRIFUGAL & TURBINE PUMPS

Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.



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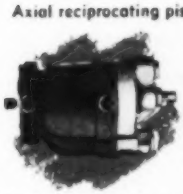
Axial reciprocating piston type . . . constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rpm with maximum of 4500 rpm . . . working pressures to 3000 psi and 5000 psi . . . direct engine and individual electric motor driven models.



Write—

For detailed information on the type of pump in which you are interested.

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Gentlemen: Kindly send additional information on the pumps I have checked.

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- ☐ Dudco Pumps
- ☐ Kinney Liquid Handling Pumps
- ☐ Kinney Vacuum Pumps
- ☐ Aurora Pumps

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merged that year with Seldon Company, of which he was a vice president.

Dr. Jaeger held hundreds of patents on important chemical manufacturing processes. Among his most important developments is a vanadium catalyst for sulfuric acid production. Following his retirement in 1951 from American Cyanamid, he served as a consultant for the company.

Rouse, Oil Industry Veteran, Retires From Stanolind Oil

John E. Rouse, vice president in charge of operations and a member of the board of directors of Stanolind Oil and Gas Company, has retired from the company, completing 40 years of service with various companies in the oil industry.

Secretaries Society Elects Harmon of Indiana Standard

Laban E. Harmon, secretary of Standard Oil Company (Indiana), has been elected president of the American Society of Corporate Secretaries, Inc. Harmon, a vice president, director and founding member of the society and a former president of its Chicago regional group, succeeds John H. Mathis, vice president and secretary of Lone Star Cement Corporation.

The election was held at the society's annual meeting at Hot Springs, W. V.

Among vice presidents elected was Lammot du P. Copeland, secretary of E. I. du Pont de Nemours & Company, Inc.

Harmon joined Standard in 1922 as an accountant in the manufacturing accounting department. He was elected assistant secretary of the company in 1931 and secretary in 1945.

HALT CORROSION WITH NEW

LONG-LASTING SPRING-KOTE

1. Can Be Applied to Damp Surfaces
2. Bonds Tightly and Securely
3. Resists Chemicals, Alkalies, Acids
4. Insulates Vessels, Hot or Cold
5. Protects, Waterproofs, Beautifies

1 An effective, new exclusive additive permits application to damp surfaces without detriment to adhesion.

2 New Spring-Kote contains no flake or crystalline-type fillers that set-up internal stresses when drying. It won't scale, crack, "void," or loosen.

3 Precise control of raw materials and consistent formulation give new Spring-Kote positive uniformity—batch-after-batch, month-after-month—for utmost reliability.

4 Retains form and efficiency from −40° F. to 450° F. Contains ground cork when used for insulation. Thicknesses up to ⅜" require no mechanical means for support.

5 Outstanding for metal-protection, for waterproofing and beautifying brick and masonry. Applied by plant maintenance crews or by nearby Authorized Applicators.

Never before has an asphaltic mastic offered users such service and savings. Write today for complete information about new and better Spring-Kote.

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General Petroleum Names Head Of Manufacturing Department

Richard E. Lauterbach has been named manager of General Petroleum Corporation's Manufacturing department. Since last November, he has been manager of General Petroleum's new Ferndale, Wash., refinery, which is now under construction.

Lauterbach

In his new post, Lauterbach will make his headquarters at the company's home office in Los Angeles.

For three years after joining General Petroleum in 1936, Lauterbach was a laboratory assistant before becoming a chemical engineer in the Laboratory department. He became assistant manager of the company's Torrance, Calif., refinery in 1950.

Texaco Elevates Logan, Holmes To Refining Department Posts

W. B. Logan and F. H. Holmes have been promoted to assistant general managers of the Refining department of The Texas Company, effective August 1, M. Halpern, vice president in charge of the department has announced.

Logan, with Texaco since 1922, has been manager of operations of the Refining department since 1950. Holmes, assistant manager of operations before his promotion, has been with the company since 1927.

T. A. Mangelsdorf, general superintendent of Texaco's Port Arthur, Texas, works since 1950, has been named manager of the Operations division in New York.

Other departmental promotions include:

L. C. Kemp, Jr., director of research, named assistant to the vice president; Kemp to be succeeded as director of research by Dr. W. J. Coppoc, and Dr. C. E. Moser made associate director of research; Dr. R. L. Sawyer advanced from supervisor of the Fuels Development Research department to assistant director of Research at Texaco's Beacon, N. Y., Laboratories, the position formerly held by Dr. Moser.

Missouri Synthetics Plant Will Be Disposed of by Sale Only

The Pentagon has been told to sell the Louisiana, Mo., synthetic liquid fuels facilities, the House Armed Services Committee has said.

Indiana Standard Lab Gets Seven University Scientists

Seven scientists and engineers from the faculties of Midwest universities have been retained as summer consultants in the Whiting, Ind., research laboratories of Standard Oil Company (Indiana). The seven are: Harold Hart, Michigan State College; Gerald W. Lawton and Robert S. Kirk, University of Wisconsin; John M. Woods, Purdue University; Murlin T. Howerton, Notre Dame University; Gilbert P. Haight, University of Kansas; and Ray T. Wend-

DU PONT REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT REG. U.S. PAT. OFF.

August ★ One of a Series of Interest to the Petroleum Industry ★ 1953

All dressed up...

IN PETROLEUM PRODUCTS!

Miss Joanne Melberg was crowned Queen of the Lakes at the Minneapolis Aquatennial Summer Festival last month.

But what, you ask, has that got to do with the petroleum business? Just this—Miss Melberg's entire wardrobe, including the nylon evening gown she is wearing in the picture above, was made of petroleum-based synthetic fibers. In addition to this nylon dress, her official Festival wardrobe contained suits, dresses, gloves, hats and a bathing suit of "Dacron" polyester fiber. And as Queen of the Festival, she is being sponsored by the Oil Industry Information Committee of the American Petroleum Institute.

This fashionable wardrobe is an excellent example of how the petroleum and chemical industries are working together to develop a world of new products that mean easier and more comfortable living for millions of people.

Textile fibers by Du Pont are only one example of the tremendous progress now being made in the development of petroleum-based chemical products. The complete roll call includes hundreds of products that make our work easier, our recreation more enjoyable, our homes more livable, our farms more productive, and our industries more efficient . . . products like anti-freeze, insecticides, synthetic rubber, weed killers, plastics, explosives, finishes, detergents and pharmaceuticals.

How motorists choose the *grade* of gasoline they buy

A merchandising opportunity is pointed up in Du Pont Survey Report No. 3 on Consumer Gasoline Buying Habits

Once the motorist has decided to buy *your brand* of gasoline and driven into the station, which *grade* will he choose? And what is the basis for his choice? Is it price . . . power . . . mileage . . . or the particular requirements of his car?

Findings on these questions are discussed in Report No. 3 of Du Pont's Consumer Gasoline Buying Habits Survey. It is now being distributed to refiners and marketers.

THREE REPORTS on Du Pont's continuing survey of Gasoline Buying Habits have been published so far. The first was a study of service station selection and loyalty. The second covered brand name recognition and loyalty. Future reports will deal with price and credit cards, oil and TBA purchases, and dealer services.

To get this information, 3,100 household interviews and 21,000 observations at 1,193 service stations were conducted as part of the Du Pont survey. National in scope, the survey is representative of gasoline buying patterns and trends throughout the country.

WEST PREFERS PREMIUM

In only one of the four major gasoline marketing areas of the U. S., does the preference for premium exceed that for regular. This is in the West where 55.2% of the motorists say they usually buy the premium grade. In the South the preference for the two grades is practically equal. In the Central area, a big majority prefer regular and regular has an edge over premium for the motorists' preference in the Northeast.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Survey Report*

PRICE FACTOR

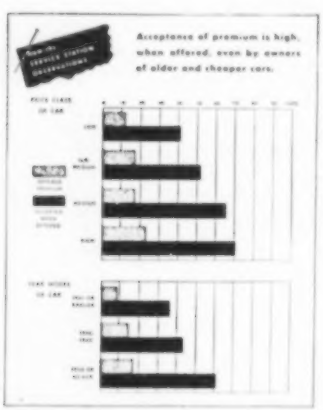
As might be expected, the customers who own more expensive cars and are in the higher income groups are the principal premium purchasers.

Among those motorists surveyed who usually buy the regular grade, 51.9% said they do so because it is *cheaper*. However, there is equal mention of performance of regular as "reason" for its selection. Many of those who usually use regular say its performance is satisfactory or equal to that of premium.

PERFORMANCE COUNTS

Among the premium users surveyed, by far the greatest majority gave reasons that added up to "performance." Of these, 56.9% specifically stated that more power, better pickup, acceleration and all-around performance were the main reasons for their choice. One-quarter said they use premium because it prevents knock. Better mileage, faster starting and high-compression engine requirements were given as reasons for choosing premium by the remainder of motorists who usually buy it.

When asked directly what they considered the *chief differences* between the two grades, the motorists surveyed supplied a wide variety of answers. Power, octane rating, starting speed, mileage and smoothness of performance were the answers most frequently encountered. Such factors as knock resistance and the addition of special ingredients received a smaller percentage of mentions.



A TYPICAL PAGE from Report No. 3 shows that customer acceptance of premium grade gasoline is high, *when offered by dealer.*

SALES OPPORTUNITY

One of the most interesting parts of this Du Pont Survey Report No. 3 deals with the way in which motorists ask for, or "are sold," a particular grade of gasoline. This part of the survey is based on the service station *observations*. These observations reveal what motorists and dealers *actually do* at the point of purchase, rather than what they *think* they do or *say* they do when questioned.

These observations showed that two-thirds of the premium purchasers requested it themselves. *Only one out of eight* of all the motorists observed were *offered premium*. However, *two out of three* of the motorists observed, who were offered premium, followed the suggestion of the dealer in grade selection. And even among the owners of older and cheaper cars, the acceptance of premium grade offers was high.

Information like this, we believe, can be extremely valuable to oil companies in planning their service station merchandising and promotion campaigns.

GULF COAST DISTRICT MANAGER

CHARLES D. TOWERY is manager of the Du Pont Petroleum Chemicals Division Gulf Coast District. He joined the Du Pont Company in 1947. After three years as a sales-service representative in the Petroleum Chemicals Division, he was made district manager of the Mid-Continent District and was transferred to his present assignment in 1952.

Mr. Towery brought to Du Pont a broad background in oil refining. It began with a B.S. degree in Chemical Engineering from Texas A&M in 1932. He then joined the sales department of the Gulf Oil Corporation.

In 1934 he joined the Smiths Bluff Refinery of the Pure Oil Company. For three years he worked on all phases of physical and chemical analysis–including knock test engines–at the refinery control laboratory.

He was transferred in 1937 to Pure Oil Company's operating department as a process engineer. There he gained wide experience in distillation, treating, pumping, blending, instrumentation and many other facets of oil refining. Later he was moved to the company's Chicago office and was assigned to pilot plant studies.

Mr. Towery was called by the Navy in 1942 as petroleum specialist. Following his discharge in 1945 as a Lieutenant Commander, he was associated with Bethlehem Supply Company as sales engineer in the Refinery Sales Department.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through any Du Pont Petroleum Chemicals Division district office:

The Service Station and the Motorist—Report Nos. 1, 2 and 3 are now ready for distribution. Authoritative studies on gasoline buying habits in regard to service station loyalty, brand name loyalty and gasoline grade selection. Serials A-5396, A-5347 and A-5826

Du Pont Fuel Oil Additive No. 2—A 12-page bulletin describing this ashless stabilizer and dispersant which prevents clogging of fuel oil screens. Serial A-5201

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A-5881

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land, North Dakota Agricultural College.

In this, the first year the company has engaged university scientists for research work during their summer vacations, each will be assigned work in his own major field of interest.

Conoco Announces Promotions For Refinery at Ponca City

Two promotions for its Ponca City, Okla., refinery have been announced by Continental Oil Company.

Lester H. Barnes, mechanical superintendent, was promoted to assistant refinery superintendent in charge of the mechanical department. He succeeds H. G. Gunter, resigned. Loyd Thompson, chief planner, was promoted to mechanical superintendent, succeeding Barnes.

Joining Conoco at Ponca City in 1928, Barnes served as an electrician until 1940, when he transferred to Lake Charles, La. He returned to Ponca City in 1942 as an electrical foreman and was promoted in 1950 to mechanical superintendent.

Thompson joined Conoco at Ponca City in 1937, transferring later that year to Wichita Falls, Texas, as resident engineer. He became resident engineer at Lake Charles in 1940. He was promoted in 1950 to chief planner at Ponca City.

Olin-Mathieson Owned Firm Will Manufacture New Chemical

Olin Industries, Inc., and Mathieson Chemical Corporation have formed Matholin Corporation to manufacture, sell and conduct research on hydrazine, a new commercial chemical.

Matholin will be equally owned by Olin and Mathieson. John M. Olin, president of Olin, will be president of the new corporation, whose board of directors will include four representatives from each of the parent companies. The new concern will acquire Mathieson's recently completed first commercial-scale hydrazine plant at Lake Charles, La., and will also take over a substantial number of patents and patent applications developed in Olin's laboratories and pilot plants.

Until recently, hydrazine has been confined to laboratory experiments, but about 2000 derivatives have now been reported. It is being used in medicinal, agricultural, plastic and many other products. It is expected to become one of the base chemicals of the future.

The joint announcement made by Olin and Mathieson said joint research efforts on hydrazine have been progressing for over a year.

Celanese Adds Shine, Wenzell to New Development Department

William A. Shine and P. Wenzell, Jr., have joined the Development department of Celanese Corporation of America. For the last three years Shine has been director of marketing development for Arnold, Hoffman and Company, Inc., American affiliate of Imperial Chemical Industries. Wenzell goes to Celanese from the U. S. Bureau of Mines, where he has been engaged in synthetic fuel development work for the past four years.

The Development department was recently established with E. T. Powers as director to study new technological developments here and abroad.

Macco Corporation Names Ash General Construction Head

L. E. Ash has been appointed general construction superintendent of the Refinery division of Macco Corporation, Paramount, Calif.

Ash

Ash has wide experience in the oil and chemical construction fields. For the past six years he has been construction superintendent, engineer and project manager for Foster Wheeler Corporation. He also served as Foster Wheeler's engineering representative in England and Norway, conducting various economic surveys.

What's **Happening** . . .

Grace Chemical Adds Mueller To Staff of New Memphis Plant

Max F. Mueller, formerly chief engineer for J. T. Baker Company, has been named chief technologist of Grace Chemical Company's $19 million nitrogen plant now under construction near Memphis. Temporarily, Mueller will be assigned to the Development department of Grace Chemical in New York until he takes up his duties at the plant.

Anglo-Iranian Moves Trantor To Aden as General Manager

A. W. G. Trantor has been appointed general manager of Anglo-Iranian Oil Company's Aden refinery. He was previously works manager at Anglo-Iranian's

Prevent thermometer fogging

No matter how long you dunk it, you can't cloud the accuracy of a Rochester dial thermometer.

THIS SUBMERSIBLE QUALITY **is important to you. It means fast, easy temperature readings . . . without any danger of a foggy crystal causing inaccuracy. Rochester dial thermometers are assembled and hermetically sealed in a special humidity-controlled "dry" room. This eliminates any possibility of condensation inside the thermometer.**

ALL STAINLESS STEEL CONSTRUCTION— **All outer parts (except crystal) of Rochester dial thermometers are stainless steel. What's more, the case, stem and nut are fused into a single *corrosion-resistant* unit by an exclusive Rochester welding process.**

EXCLUSIVE OUTSIDE RECALIBRATION— **Rochester makes the *only* industrial thermometer that can be recalibrated from outside the case. If an extremely hard blow should knock it out of adjustment, you can have it back on the job in less than a minute . . . without taking the thermometer apart or breaking the hermetic seal.**

You can order Rochester thermometers from one of our specialized instrument representatives listed in Sweet's Catalog. Just mail the handy coupon for full details.

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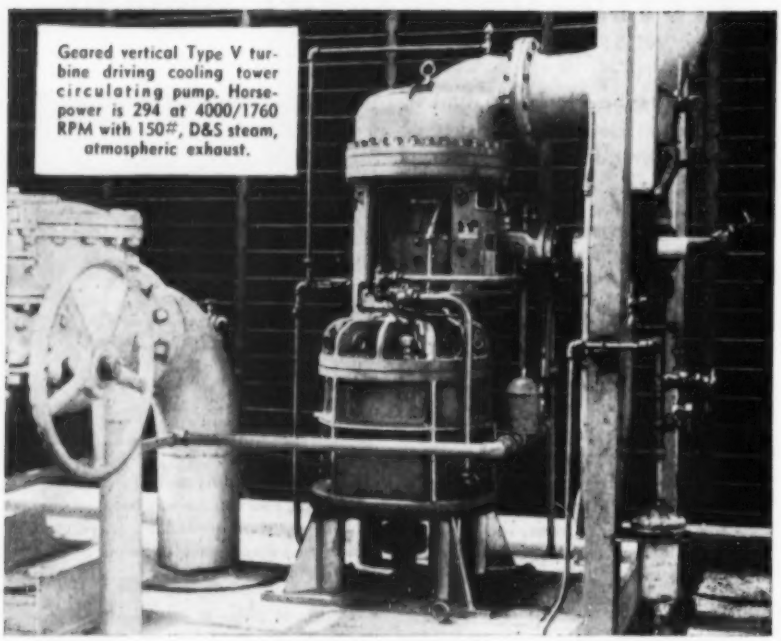

Geared vertical Type V turbine driving cooling tower circulating pump. Horsepower is 294 at 4000/1760 RPM with 150#, D&S steam, atmospheric exhaust.

● Murray Vertical V turbines, both geared and direct-connected, are being used more and more for driving vertical pumps of all types. The Murray Vertical V turbine is designed from top to bottom as a vertical turbine, not just a horizontal turbine, "upended." The Murray Vertical is especially constructed and arranged for vertical mounting.

Murray vertical turbines can be furnished for steam pressures up to 600#, 750° F. TT. and back pressures as high as 100# and can carry most normal thrust loads imposed by vertical pumps.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

What's **Happening** . . .

new 80,000-barrel-a-day Kent oil refinery on the Isle of Grain, England. A. Patrickson, who joined Anglo-Iranian in 1922, succeeds Trantor as works manager at Kent.

University of Michigan Hosts Phase Behavior Conference

Eight formal papers headed the program of the Research Conference on The Phase Behavior of the Hydrocarbons held last month at the University of Michigan. Of the 80 people gathered to hear the papers and enter into discussion of phase behavior, 30 had been at the University for two weeks prior to the conference attending an intensive course on the phase behavior of hydrocarbons. Papers and discussion were on three areas of interest: mixtures at low temperatures, naturally occuring systems in petroleum reservoirs and non-ideal systems. Dr. Roger H. Newton, Badger Manufacturing Company, addressed the group on a comparison of "exact" and "engineering" science.

In the panel discussion, Dr. Riki Kobayashi, Rice Institute, presented the present status of information at low temperatures and included a correlation of equilibrium relations for complex systems containing hydrogen which had been developed during the intensive course.

In reviewing the reservoir problems, Dr. E. I. Organick, United Gas Corporation, stressed the need for more information on the nature of high boiling constituents present in crude oils and condensate.

Dr. J. A. Gerster, University of Delaware, reviewed the situation relative to non-ideal systems, as did the paper by Professor G. M. Brown, Northwestern University. The paper by Dr. Donnelly, Wayne University, showed a unique behavior of carbon dioxide in the Methane-carbon dioxide system.

D. C. Gami presented a paper on phase behavior studies at Illinois Institute of Gas Technology.

Dr. Fred Poettmann, Phillips Petroleum Company, presented the ethane-ethylene system in which vapor liquid equilibria data were correlated by the Gibbs-Duhem relationships to provide an excellent set of data at low temperature for the system.

The paper by Dr. Brymer William and Dr. D. L. Katz, University of Michigan, presented data on the behavior of hydrogen with the volatile hydrocarbons.

Other papers presented the phase relationships of binary systems of alcohols and ether and discussed the application of the equation of state and its usefulness in the fundamental or long-term view in correlating experimental data.

Professor Brymer Williams was general chairman of the meeting.

Hydrocarbon Research Elected To Constructors Association

The National Constructors Association has elected to membership Hydrocarbon Research, Inc. The association is an organization composed of leading engineering and building firms engaged in the design and construction of chemical plants, steel mills and petroleum refineries.

A Logical Way to **CURE** Salt-water **CORROSION TROUBLES**

70-30 CUPRO-NICKEL TUBING keeps heat-transfer capacity *up* by keeping corrosion *down*. TIDE WATER ASSOCIATED OIL COMPANY, Bayonne, N. J., utilizes large quantities of this alloy in the form of AMERICAN BRASS COMPANY'S Anaconda Super Nickel 702 tubes. This tubing gives TIDE WATER excellent service in heat exchangers subject to the highly corrosive salt water from the Bayonne Harbor as coolant.

Here's how TIDE WATER ASSOCIATED OIL COMPANY uses the cure . . .

Existing tubes in the majority of exchangers cooled by salt water are being replaced with 70-30 cupro-nickel alloy tubing.

During World War II cupro-nickel condenser tubes were reserved exclusively for naval vessels and tankers, but in 1947 TIDE WATER began to make sizeable replacements . . . using large quantities of Anaconda Super Nickel 702 tubing produced by THE AMERICAN BRASS COMPANY, Waterbury, Conn.

Thin walls of this strong tough alloy resist corrosive and erosive attacks from various cooling media, including polluted, silt-laden waters of harbors and estuaries.

Along with ability to withstand a wide variety of corrosive agents, the 70-30 cupro-nickel tubing provides outstanding resistance to pitting and stress corrosion cracking. Moreover, with cupro-nickel, there is no danger of dezincification.

Wherever heat-transfer capacity is a factor . . . where wall thickness allows but little tolerance for effects of corrosion and erosion . . . specify 70-30 cupro-nickel tubes. They eliminate those hidden taxes on profits represented by maintenance and replacement expense, loss of heat transfer capacity and interruptions of operation resulting from corrosion.

Cupro-nickel is produced in tubing, rod, strip, wire and sheet, and also in cast form. We shall be glad to give you additional information about these versatile alloys and help you select the one best suited to your requirements. Write us today.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

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What's New in Manufacturers' Literature

For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Organic Chemicals Addition

The first supplement to its current published list (No. 38) of more than 3500 organic chemicals it supplies has been announced by Eastman Kodak Company. The supplement lists 40 additions to the catalog, showing the name of the chemical, its melting or boiling point, structural formula, molecular weight and price according to quantity. It also includes removals and price changes.

Included among the new compounds listed are such items as 2-(o-Hydroxyphenyl) benzoxazole, a reagent for the gravimetric determination of cadmium with a minimum of interference by most of the common metallic ions. It is said to give results accurate to better than 0.2 mg in samples containing from 5 to 50 mg of cadmium, and purified natural pulegone, a liquid of boiling point 95-98 F. at a pressure of 12 mm which is present in such essential oils as oil of pennyroyal and oil of peppermint. This purified pulegone has a characteristic odor and flavor somewhat reminiscent of peppermint oil, and can be converted into other mint-flavored materials.

Circle No. 1 on Postcard

Barrel Handling

"The Logistics of Barrels," an eight-page booklet offered by Elwell-Parker Electric Company, explains many cost-cutting methods for handling of barrels and barrel shapes by power industrial trucks. The illustrated publication explains how any cylindrical-shaped container can be assembled on pallets or skids for effective handling.

Circle No. 2 on Postcard

Control Instruments

A new catalog of control instruments for furnaces, ovens, dryers and kilns has been published by The Bristol Company. Featured in the catalog are electronic dynamaster potentiometer and millivoltmeter type pyrometer controllers, recorders and indicators. A variety of electric, air-operated, electronic control instruments for use with fuel-fired and electric heating equipment of all types is listed. Complete engineering specifications and prices are given.

Circle No. 3 on Postcard

Pipe Fabrication

Fabrication of pressure piping for industrial use is the subject of a 16-page brochure recently released by Western Piping Supply division of The Lummus Company. Entitled "Meet Western Piping Supply," the booklet presents a pictorial tour through the company's fabricating plant. Pictured and described are shop facilities and the steps taken in producing pre-fabricated piping for the power generation, petroleum refining, chemical and heavy industries.

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What's New in Manufacturers' Literature

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Stress Rupture Values

A new data card published by the Tubular Products division of The Babcock & Wilcox Company presents stress rupture data on a number of B&W Croloy tubing steels and other materials designed for high temperature service. The card, known as TDC-153, should be of interest to engineers associated with the design of equipment operating under stress at high temperatures over longer periods of time.

In essence, the stress-rupture test is an overloaded creep test which is continued to actual failure of the specimen. The tests are made by subjecting a series of test bars to static stresses of various magnitudes at the selected temperature level and determining the time for fracture.

Circle No. 5 on Postcard

Motor Starters

Allis-Chalmers Manufacturing Company's size 0-3 ac across-the-line motor starters are described in a new eight-page bulletin released by the company. The booklet covers manual and magnetic types of starters, and combination and reversing starters as well as push button control stations. Operating arrangements are described.

According to the bulletin, all starters are equipped with thermal overload protection devices and the magnetic starters can be connected for either low voltage protection or low voltage release.

Circle No. 6 on Postcard

Sulfur Content Measurement

The Consolidated Titrilog is discussed in a new folder published by Consolidated Engineering Corporation. Offered in the 26-102 cabinet model and the Model 26-103 portable unit, the Titrilog "represents an effective, economical means of continuously, automatically recording the concentration of sulfur compounds in gas streams or atmosphere."

Among the features of this chemical-electronic instrument listed in the folder are high sensitivity, versatility and fast response. An important phase of its application is air pollution study and monitor-recording of such substances as sulfur dioxide and hydrogen sulfide caused by effluent gases, toxic leaks, or accidental discharge within a plant.

Circle No. 7 on Postcard

Nickel Steel Tubing

The mechanical and working characteristics, heat treating behavior and weldability of a new 9 percent nickel and steel tubing are contained in a new brochure published by The International Nickel Company, Inc. In ten pages of charts, tables and photographs, the booklet presents data showing that the tubing is suitable for low (—320F.) temperature service; also for the oil industry where chloride salts, hydrogen sulfide, carbonic acid and certain organic chemicals are encountered; for the paper industry where sodium hydroxide and black liquors are met; and for the chemical industry because of its greater resistance than ordinary carbon or low alloy steels to corroding influences, and its toughness and high physical strength.

Circle No. 8 on Postcard

Petroleum Books Catalog

Gulf Publishing Company's Book department has issued a new catalog of petroleum books published by or available through it. The catalog gives descriptions, subject material and prices of over 125 currently available books written by authorities on almost every phase of the petroleum and related industries. The catalog is free on request.

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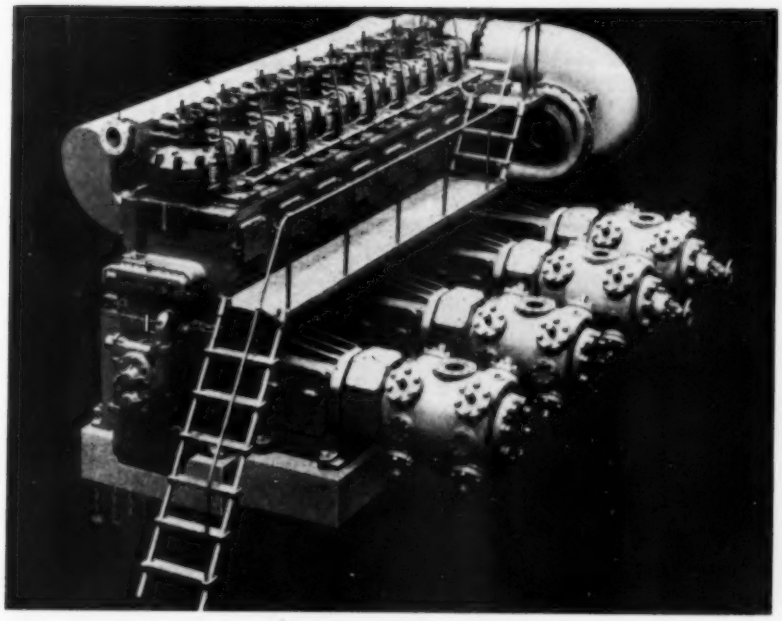


Turbocharged Compressor Unit

First unit of its type produced in the U. S. claims 50 percent more power than any non-turbocharged unit of comparable bore and stroke.

The new Clark Bros. Company Model TRA is the first turbocharged 2-cycle, right-angle, gas-engine-driven compressor unit produced in the U. S. The unit, which develops 1320 brake horsepower, has eight vertical, in-line cyclinders of 14-inch bore and 14-inch stroke, integrally connected to horizontal compressor cylinders.

The TRA represents a unitized, integrated design. The turbocharger and compressor have been specificially designed and built by Clark to operate as a "perfectly matched, balanced unit."

Some of the outstanding features claimed for the Clark TRA are:

Fifty percent more power than any non-turbocharged unit now built of comparable bore and stroke.

Conservatively rated and guaranteed to burn substantially less fuel than any gas-engine-driven compressor now built.

Twenty-five percent less water cooling load.

Fuel consumption practically constant between 70 percent of load and maximum load.

Quieter operation; noise is converted into energy.

The unit was built to match the characteristics of its companion gas-engine-driven compressor. It operates at conservative speeds and temperatures for extremely long life and dependability.

For its size and horsepower, the manufacturer says, the Clark TRA is the most rugged compressor ever built.

This item supplements Clark Bros. Company data on pages 301-302 of The Refinery Catalog, 20th Edition.

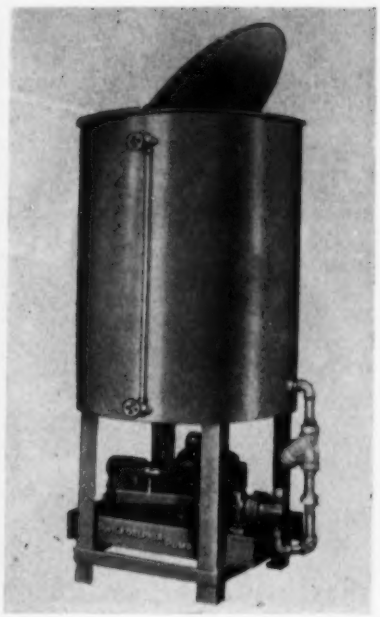
Circle No. 10 on Postcard

Lightweight Couplers

A new technical catalog issued by Snap-Tite, Inc., lists the features of its new "Hi Flow Line" of quick connect-disconnect couplers. Features listed include: greater flow; smaller dimensional size; less weight; and higher pressure applications.

According to the manufacturer, the couplers indicate up to 80 percent flow, can be made in sizes from ¼ inch through 8 inches and even greater in diameter. The new couplers will handle air, water, oil, gas, steam and most chemicals.

Circle No. 11 on Postcard



Chemical Feed Unit

Philadelphia Pump and Machinery Company's packaged chemical feed unit is completely piped, ready for connections to the plant chemical feed piping and to the electrical control equipment, whether manual or automatic, The unit is a self-contained assembly comprising a sturdy welded steel chemical solution-tank of 50- or 100-gallon capacity mounted above a controlled capacity pump. It operates directly from available electrical circuits. It is supplied with sight gage and a "special" steel strainer between the pump and tank.

The manufacturer reports that mechanical agitators can be provided to supply vertical agitation rather than the usual horizontal type. Controlled capacity pumps are available in either simplex or duplex types.

Circle No. 12 on Postcard

Safe Flowmeter

Purging or freezing of instrument lines can be eliminated by Flovane, Line Engineering Company's new flowmeter. The unit utilizes the principle of flow velocity instead of pressure-drop taps. No long, straight approach and discharge are required, as in most flowmeters.

Normally hazardous fluids are safely metered with this new unit, the manufacturer reports. The metered fluid need never leave the pipe, since indication is remote and obtained by air pressure to the indicator rather than by routing fluid to be measured through the measuring device.

A further safety feature of Flovane is that it is explosion-proof. Since no electric circuits are used, there is no danger from electric sparks. Adaptable, it may be used to measure pressures from 0 to 3000 psi.

Circle No. 13 on Postcard

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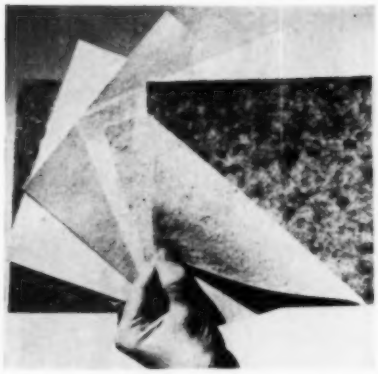


Fibrous Glass Paper

Papers made of extremely fine fibers of glass and which have inherent high temperature resistance and excellent electrical-chemical properties are now being used in a variety of industrial specialty applications.

The incombustible, inorganic industrial papers are being used for the filtration of hot and/or corrosive air, gases and liquids. These papers are also finding application as base sheets in specialty electrical laminates, as gasketing material, and as plate separators in aircraft and other special batteries.

Owens-Corning Fiberglas Corporation sells the fibrous glass in its wool form to the various paper companies which process the fibers and manufacture the finished paper product.

This item supplements Owens-Corning Fiberglas Corporation data on pages 817-820 of The Refinery Catalog, 20th Edition.

Circle No. 14 on Postcard

Controlled Volume Pumps

Design and construction of Milton Roy Company's motor drive controlled volume pumps are described in the company's new Bulletin 553. Technical data in the booklet include capacity-pressure selection tables; types of capacity adjustments; standard and special designs, as well as packaged systems. A two-page chart describes typical applications in six major industries. Also included is a four-page materials section chart.

Circle No. 15 on Postcard

New Ball Float Trap

Armstrong Machine Works has added a new trap, No. 21-312, to its ball float trap line for discharging water and light liquids from gas or venting gas from liquids. This trap, the manufacturer says, offers the advantages of small size, low cost and high maximum operating pressure (400 psi).

Body and cap of the No. 21-312 are forged steel; the valve is chrome steel; and other parts of the mechanism, including the float, are stainless steel. Height of the trap is $10\frac{3}{16}$ inches and the diameter is $6\frac{1}{4}$ inches.

This item supplements Armstrong Machine Works data on page 158 of The Refinery Catalog, 20th Edition.

Circle No. 16 on Postcard

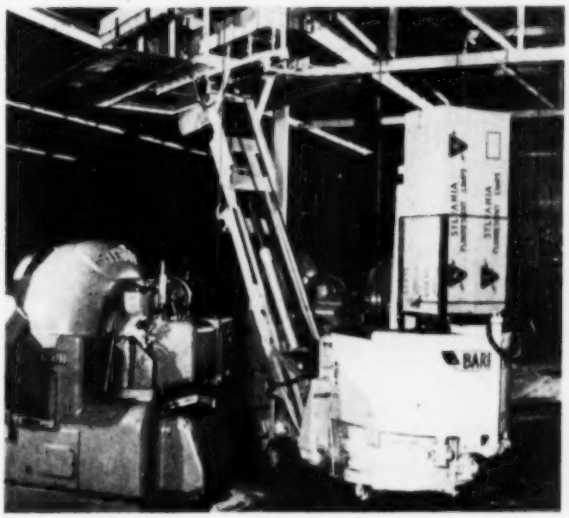
Meters and Controls

Bailey Meter Company's Bulletin 18 is a comprehensive catalog offering information on the complete line of meters, control equipment and engineering services by the company. It is written for engineers in power plants, public utilities and process plants.

Fifteen measured variables common to power and process operations form the index for selecting appropriate metering and control equipment. Basic specifications, illustrations and detailed literature references are included.

Circle No. 17 on Postcard

Time-Saving Maintenance Unit



Lift-A-Loft is a new unit developed by Barrett-Cravens Company to eliminate overhead maintenance problems, cut costs and reduce to one man the gang often required to make such jobs safe.

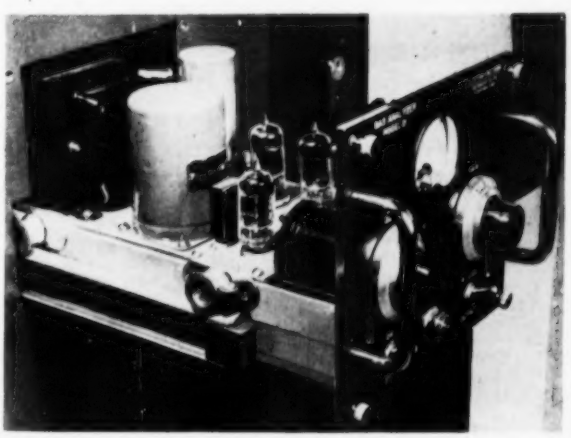
A typical application is in cleaning and replacing fluorescent lights. Where two men had required one hour to do four units with the ladder and scaffold method, one man with a Lift-A-Loft does the same work in less than ten minutes.

This versatile unit enables the maintenance man to reach ceiling objectives quickly and safely with a minimum of disturbance to production workers. One man rides the battery-powered unit to his destination, pushes a button, and is up in the air ready to work. No time is lost moving ladders, carrying tools and equipment. The platform is equipped to carry everything needed.

The platform of the Lift-A-Loft fully raised is 12 feet 8 inches above the floor. Overhead tasks such as cleaning and oiling motors, repairs, and fan installation become low-cost jobs through its use.

Circle No. 18 on Postcard

Sensitive Plant-Stream Analyzer



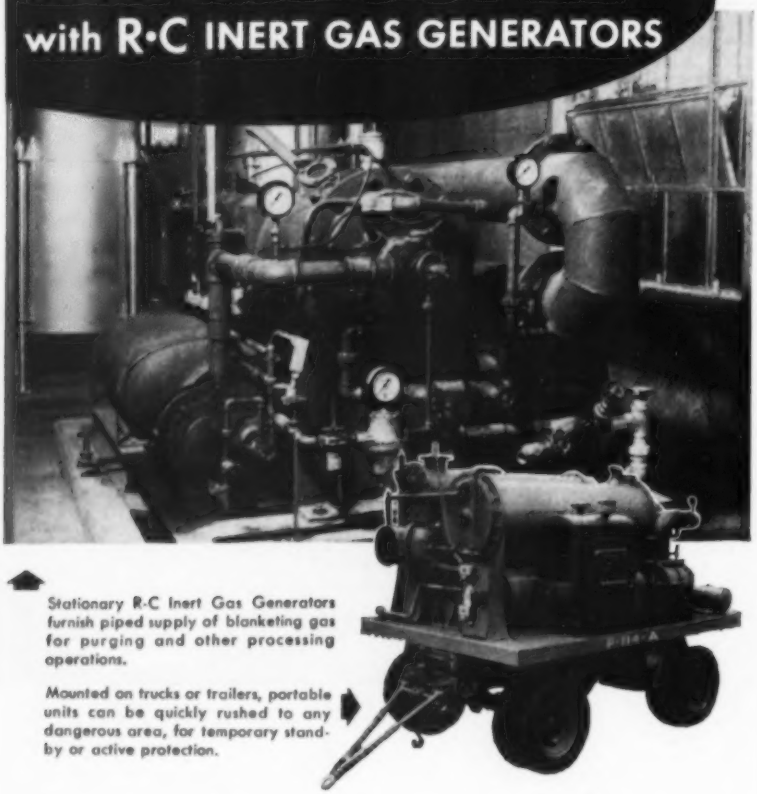
A highly sensitive and selective plant-stream analyzer is now being manufactured by Liston-Becker Instrument Company. This analyzer can be applied to the automatic control of many continuous-flow chemical processes by quality-analysis of the end product.

The instrument is a positive-type infrared-absorption gas analyzer comprising two sections: an electronic controller to be located in the plant control room; and a weather-tight, explosion-proof pickup that can be placed anywhere in the plant stream up to several hundred yards away from the controller.

Variations of as little as one part per million in the quality of the product will "trigger" corrective action, within a half-second or less, to restore the product to its ideal quality. Containing no optical or mechanical parts, the analyzer employs only four vacuum tubes and is compact and rugged.

Circle No. 19 on Postcard

REDUCE EXPLOSION RISKS with R·C INERT GAS GENERATORS



Stationary R-C Inert Gas Generators furnish piped supply of blanketing gas for purging and other processing operations.

Mounted on trucks or trailers, portable units can be quickly rushed to any dangerous area, for temporary stand-by or active protection.

Where materials or processes may cause explosion-produced fires, such hazards can be greatly lessened by stand-by R-C Inert Gas Generators.

From stationary or portable units, a continuing flow of inert gas will blanket dangerous areas or can be used for purging explosive gas or liquid lines. Using either oil or gas as fuel, they operate at very low cost. Frequently, the comparatively small investment can be absorbed by more favorable insurance rates.

Units are available in capacities from 1,000 cfh to 50,000 cfh, with characteristics to match specific requirements. Write for details on how your fire and explosion risks may be reduced with R-C Inert Gas Generators . . . built by the specialists in equipment to handle gas and air.

ROOTS-CONNERSVILLE
Exclusive Specialists in Handling Gas and Air

ROOTS-CONNERSVILLE BLOWER A DIVISION OF DRESSER INDUSTRIES, INC. 533 Crescent Ave. • Connersville, Indiana

NEW Equipment . . .

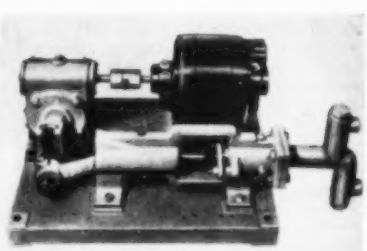
Portable Fire Extinguishers

A new complete line of portable carbon dioxide fire extinguishers has been announced by American-LaFrance-Foamite Corporation. Five Alfco models of this design, which has a new and simplified, faster-acting valve, are available: Models Nos. 2½, 5, 10, 15 and 20, the model numbers denoting also the weight capacity of the respective units.

The new extinguisher valve has a number of improvements over the valve it replaces, including: increased simplicity—disassembles for servicing without special tools; operates faster—squeeze level directly over the valve stem gives quicker discharge; pressure; removable siphon tube; safety disc is side-mounted instead of on top for added protection against damage.

Double-prong locking pin (two locking ends), with one prong slightly sprung, prevents locking pin from falling out while extinguisher is being moved.

Circle No. 20 on Postcard



Small and Compact Pump

Small and compact, Orlich Bros. Machine Works' "Little Giant" pump is designed for water softening, boiler treatment and all chemical applications up to 800 psi. It features a new ball and seat design for "efficiency and economy."

Suction and discharge sides consist of integral ball and seat units (two balls and two seats) in one complete unit. These units are easily removed with a

CAT CRACKER AT ARKANSAS CITY

Chicago Bridge & Iron Company furnishes reactor and regenerator

A 9-ft. 6-in. diam. by 34-ft. 6-in. reactor and a 15-ft. diam. by 38-ft. 6-in. regenerator were fabricated in our Chicago plant for the UOP Catalytic Cracking Unit shown at the right. This installation was built for the Refinery Engineering Company of Tulsa at the Anderson-Pritchard Oil Corporation refinery in Arkansas City, Kansas. It has a capacity of 4,600 bbls. per day and produces gasoline and heating oils from gas-oil.

Chicago Bridge & Iron Company builds reactors, regenerators, refinery towers, Hortonspheres, Hortonspheroids, Horton Floating Roofs, Vaporspheres, Vaportanks, Hortondome Roofs, and other welded steel plate structures for the petroleum industry. For information, estimates or quotations, please write our nearest office. There is no obligation on your part.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Healey Building	Detroit 26	1520 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Pittsburgh 19	3237 Alcoa Building
Boston 10	1030—201 Devonshire Street	Houston 2	2126 C & I Life Building	San Francisco 4	1551—200 Bush Street
Chicago 4	2463 McCormick Building	Los Angeles 17	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Midland Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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Compagnia Tecnia Industrie Petroli, Rome, Italy
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
Sociedade Chibridge de Construcoes Ltda., Av. General Justo, 275, Grupo 306, Rio de Janeiro, Brazil
Horton Steel Works Limited, Fort Erie, Ontario, Canada
Motherwell Bridge & Engineering Company, Motherwell, Scotland
Whessoe, Limited, Darlington, England
Comprimo N. V., 21, Amstel, Amsterdam (C) Netherlands

NEW! handy guide on Refinery Painting

Puzzled over painting problems? Here's a new guide that takes the guesswork out of refinery painting. In 12 easy-to-read pages, with painting recommendations in handy check chart form, it tells at a glance the right paint to use on each type of interior or exterior surface—for surfaces exposed to various temperatures and operating conditions.

Included are suggestions on surface preparation and helpful painting hints.

Ask for your copy . . . write for Brochure A-770. The Sherwin-Williams Co., Petroleum Division, Cleveland 1, Ohio.

SHERWIN-WILLIAMS
PETROLEUM FINISHES

COVER THE EARTH

NEW Equipment . . .

repeatability from 0 to 100 percent of rated capacity. This is adjustable when the pump is not in operation, locking in place for safety regardless of pressure. A separate gear reducer is standard, allowing the use of readily available standard motors for replacement.

Circle No. 21 on Postcard

Explosion-Proof Telephone

A new explosion-proof telephone, for use by industry wherever a spark of electricity might ignite inflammable gases or explosive dusts, has been developed by Crouse-Hinds Company. The new phone is sheathed in two sections of aluminum housing that are made flame-tight by accurately machined joints and large screws.

Unlike ordinary telephones, it is powered by the sound of the human voice alone. The voice causes fluctuations in the magnetic circuit of the phone's transmitter which creates an electrical current. This current is transmitted to the receiver where sound waves are created, reproducing the speaker's voice.

In addition to its safety feature, the explosion-proof telephone also permits communication with other sound-powered telephones within a range of 30 miles. It is equipped with a magneto-powered howler that develops a penetrating signal, loud enough to be heard in an extremely noisy area.

Equipped with a selector switch for obtaining the desired station, the telephone has U. S. Instrument Company howlers and handsets. This makes possible installation in hazardous areas on the same system with U. S. Instrument Company telephones in non-hazardous locations.

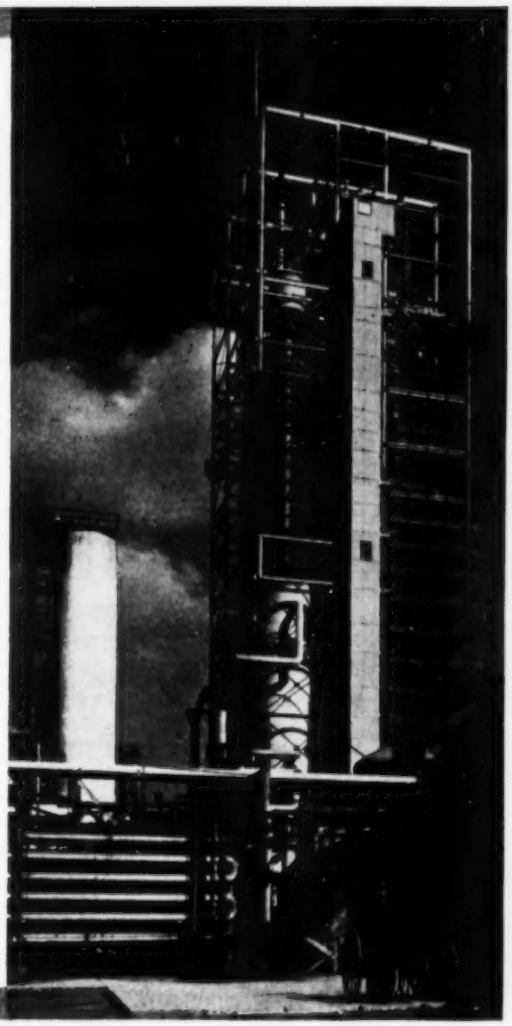
This item supplements Crouse-Hinds Company data on pages 326-327 of The Refinery Catalog, 20th Edition.

Circle No. 22 on Postcard

Corrosion Solution

Boltaron 6200, a rigid, unplasticized Polyvinyl Chloride, is the subject of a new booklet issued by The Hartwell Company. The folder, actually a data

Forty billion barrels ago—



Measured in years, it is less than a century since Colonel Drake drilled the first oil well, in 1859. Measured in terms of the gigantic American petroleum industry which grew from his pioneering enterprise, the August day when his well spurted forth the long-sought oil was more than forty billion barrels ago.

Two thousand barrels was the output in 1859. About two billion barrels now come yearly from American wells to meet the demands of the modern motor and the varied other uses of petroleum products.

For decades, Sun Ship has played an important part in construction of the refinery equipment . . . fractionating towers, condensers, pressure vessels, machinery and other equipment . . . to meet these demands. The facilities, modern manufacturing methods and skilled personnel at the great Sun Ship plant provide a combination that has consistently shown its ability to serve the petroleum, chemical and petrochemical industries in the task of building a greater America.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE (SINCE 1916) CHESTER, PA.

25 BROADWAY • NEW YORK CITY

Check these advantages of

IMPRUVOL 33®
Gasoline Antioxidant!

- ✓ **EQUALLY EFFECTIVE IN BOTH MOTOR AND AVIATION GASOLINES,** "Impruvol 33" retards the formation of gum resulting from oxidation.
- ✓ **WILL NOT CONTRIBUTE TO INDUCTION SYSTEM OR ENGINE DEPOSITS.** In fact, "Impruvol 33" *reduces* engine deposits in actual performance.
- ✓ **WILL NOT IMPART COLOR TO GASOLINE** since it does not form undesirable color bodies with trace compounds.
- ✓ **CAN BE ADDED EARLY IN THE REFINING PROCESS** when the gasoline is most susceptible to inhibitor addition. Available in easy-to-use liquid or flake form.
- ✓ **CANNOT BE EXTRACTED FROM THE GASOLINE** by water, caustic, clay, or the commonly-used pipe line corrosion inhibitors.
- ✓ **MAY BE USED TO INHIBITOR-SWEETEN SOUR GASOLINE.** Replaces doctor and copper sweetening.
- ✓ **SAFER TO HANDLE** since it is practically non-toxic and non-irritating.
- ✓ **MORE ECONOMICAL** on an active-ingredient performance basis than any of the gasoline antioxidants now being used.

For further information on "Impruvol 33" or DBPC, write:

KOPPERS COMPANY, INC.
Chemical Division, Dept. PR-83, Pittsburgh 19, Pa.

KOPPERS® **Koppers Chemicals**

NEW Equipment . . .

sheet, lists properties of the product and presents some of its typical fabrications. According to the folder, "continuing laboratory tests already have shown Boltaron's outstanding chemical resistance to the corrosion caused by organic and inorganic acids, alkalies, alcohol and foodstuffs."

Circle No. 23 on Postcard

Refractory Materials Gun

Mexico Refractories Company has developed the Refract-O-Rite Gun for use in connection with the pneumatic emplacement of castable refractory products. The unit is an innovation in the field of "shooting" materials in place rather than pouring or troweling.

Principal advantage of the gun, as listed by the manufacturer, is that the correct amount of water is added in the mixing chamber of the unit, and the aggregates in the materials remain in proper balance and in suspension as the mixture is conveyed through the hose and sprayed, with controlled air velocity, to the target. The gun thus overcomes the seriousness of separation of aggregates in the mix and improper wetting. Rebound loss is reduced to less than 5 percent. The gun's finger-tip density control is easily regulated at the nozzle by the operator. Refractory materials may be applied with a dense, abrasion-resisting mass, or an open, porous-type, insulating body.

Circle No. 24 on Postcard

Industrial Wire Cloth

Cambridge Wire Cloth Company has issued a brochure describing its line of wire cloth, both in bulk and in fabricated parts. Some of the company's facilities, as well as types of wire cloth, are pictured.

Circle No. 25 on Postcard

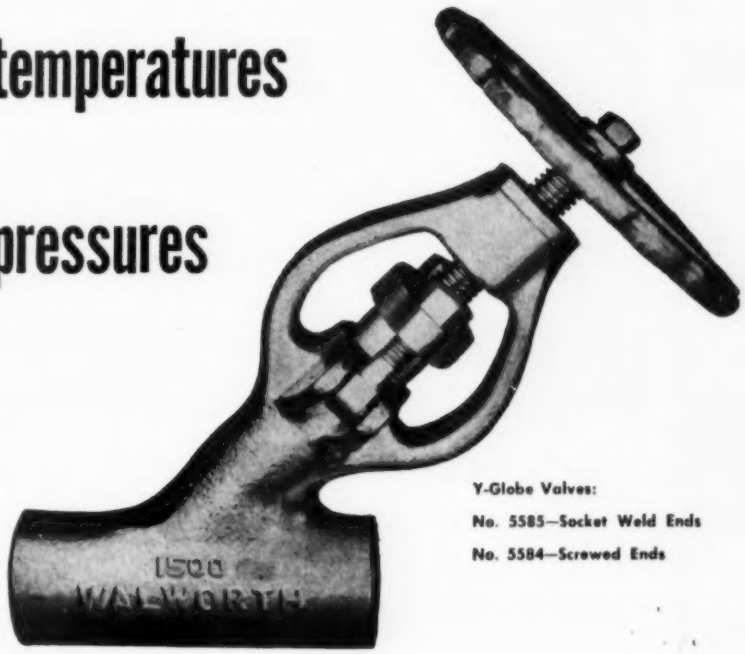
Correct Engines Ratings

In the June, 1953 Petroleum Refiner (New Equipment section, page 168), the ratings of The Cooper-Bessemer Corporation's 4-cycle, Type LS engines were erroneously given as "from 690 to 250 hp." The correct ratings of the engines are 690 to 2500 hp.

Walworth's NEW small cast steel valves

SERIES 1500 — SIZES ¼ to 2 inches

handle { HIGH temperatures / HIGH pressures



Y-Globe Valves:
No. 5585—Socket Weld Ends
No. 5584—Screwed Ends

Walworth is proud to make these new Small Cast Steel Valves available to power stations . . . oil refineries . . . ships . . . wherever piping is subject to severe pressures and temperatures. Non-shock service ratings of these valves: 1500 psi–950F for steam; 3600 psi–100F for water, oil or gas. Cast of chromium molybdenum steel, they are compact and light, yet exceptionally strong. Both Y-Globe and Angle type valves are available.

Angle Valves:
No. 5587—
Socket Weld End
No. 5586—
Screwed End

Simplified Walworth design eliminates many of the valve problems encountered in high pressure service. Among the features of this new valve are:

INTEGRAL BODY AND YOKE — made from a single casting without threading or welding. Bonnet joint — always a potential source of leakage — is eliminated. Valves can be reassembled quickly and easily.

ROTATING DISC — prevents valve seat distortion and consequent leakage. Cuts down replacements.

WELDED SEAT RING — compensates for changes in pressure and temperature—eliminates a major source of leakage.

SPECIAL BACK SEAT BUSHING — permits repacking the valve under pressure with greater safety.

PACKING CHAMBER — designed to dissipate heat thus keeping packing rings at lower temperatures—gives them longer life.

These valves are available with either socket weld ends or screwed ends, in sizes ranging from ¼ to 2 inches. For further information on Walworth series 1500 Small Cast Steel Valves, see your local Walworth distributor, or write for Circular No. 134.

WALWORTH

valves • fittings • pipe wrenches

60 EAST 42nd STREET, NEW YORK 17, N. Y.

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New Equipment Literature

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the identifying key number of each item in which you are interested. Postcards are opposite page 172.

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TUBE CLEANERS AND EXPANDERS—Information. Airetool Manufacturing Co. See page 220.
Circle A2 on postcard.

STEEL FLOOR PLATE—Booklet AL-19. Alan Wood Steel Co. See page 193.
Circle A3 on postcard.

AIR COMPRESSORS—Information. Allis-Chalmers Manufacturing Co. See page 5.
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INSULATION MATERIALS—Information. Baldwin-Hill Company. See page 208.
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TANK SUCTION AND LINE HEATERS—Bulletin No. 521. The Brown Fintube Co. See page 156.
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PROCESS AMMONIA PLANTS—Bulletin A-101. Chemical Construction Corp. See page 39.
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CORRUGATED METAL GASKETS—Information. Chicago-Wilcox Mfg. Co. See page 232.
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BALL BEARING SWIVEL JOINTS—Catalog 53-C. Chiksan Company. See page 50.
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MECHANICAL SEAL—Booklet. Crane Packing Co. See page 188.
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TUBE CLEANERS—Bulletin Y-29. Elliott Company. See page 151.
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PUMPS—Bulletin No. B-1605. Peerless Pump Division, Food Machinery & Chemical Corp. See page 37.
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GEAR PUMPS—Bulletin 17-A. Schutte & Koerting Co. See page 47.
Circle P6 on postcard.

REFINERY PAINTING GUIDE—Brochure A-770. The Sherwin-Williams Co. See page 178.
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Continued on Page 184

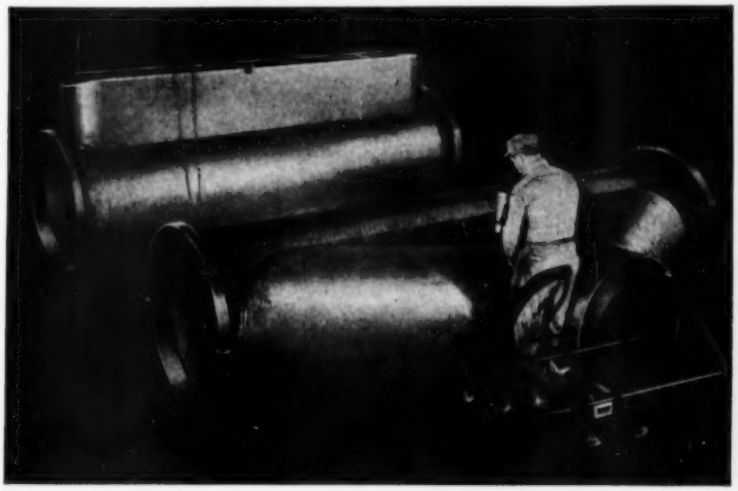
PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY AUGUST 1953

Exchangers Headed for Sumatran, African and Domestic Plants

Undergoing hydrostatic tests and inspection prior to shipment is this group of exchangers (see below) headed for several domestic refinery sites. Others, now being fabricated, will soon be shipped to a refinery in Palembang, Sumatra, and to South Africa.

The exchangers scheduled for South Africa are most unusual in that they will handle products at temperatures up to 1775°F. Specially-developed for this particular operation, the five units are being fabricated in the U.S. by Kellogg because of the firm's extensive experience in the welding of high alloy equipment.



Tubes and tube-sheets of the exchanger are being fabricated of Type 310 stainless steel. The shells are insulated on both the inside and outside. When in service the units will be employed for pre-heating feed gas going to a reformer that produces reaction gas for the synthesis of gasoline.

Minimum Pressure-drop in Unusual High-Vacuum Condensers

These are the shells for two of four special vacuum condensers scheduled for installation this summer in a major Gulf Coast refinery. When in service they will condense the overhead from a vacuum tower which is part of a three-stage pipestill now under construction.

They are designed to operate on the shell side at 53.5 mm of mercury. To obtain a minimum pressure drop of 1.65 mm, an unconventional design is used which permits a cross flow on the shell side.

Products Enter Through 36" Nozzle

A mixture of hydrocarbons, steam and inert gases enters the first condenser through the 36-inch diameter nozzle shown in the photograph to the right of the welder. Temperature is reduced from 175°F to 93°F as it passes through the two condensers which are connected in series. In the process all of the hydrocarbon material and most of the steam is converted to a liquid state.

When completed, the 44-inch shells will contain 16-foot admiralty tubes on a $1\frac{1}{4}$" square pitch. Tube sheets will be of naval brass as will the tube supports. Remainder of these two-stage condensing units will be made of carbon steel.

For further information, details of methods, etc. contact

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SHOWN HERE is the shell fabrication section of Kellogg's heat exchanger facilities which has been streamlined for production-line manufacture of tubular heat transfer equipment. Other sections of the plant have also been rearranged and new fabricating equipment has been added to accelerate the production of the wide variety of units regularly coming into the shop.

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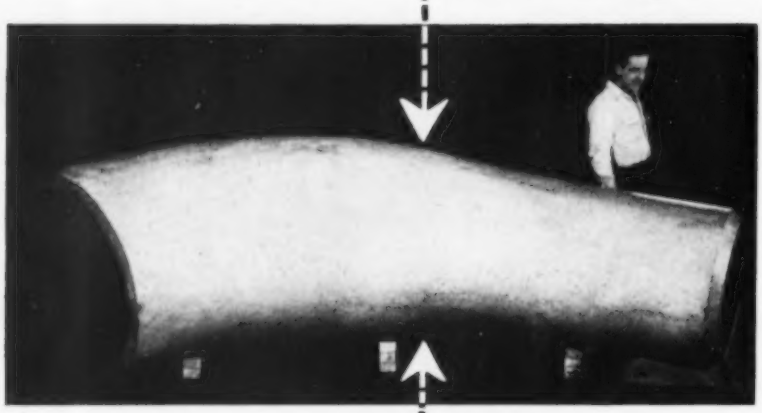
This Casting



Casting weight
21,000 pounds

Shipping weight
14,000 pounds

Alloying Elements
38% Ni., 18% Cr., 2% Mo.

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It's the weight rather than the Ni-Cr content that's the record.

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The significant fact is that this casting, the first of this size we have ever produced and destined for a most important high priority processing job, passed inspection with flying colors. *There was no reject here.* It is indicative of the skill of our metallurgists and foundrymen in turning out high alloy castings.

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New Equipment Literature . . .

PROCESS VALVES—Bulletin 698. W-K-M Company. See page 57.
Circle R9 on postcard.

CAST STEEL VALVES—Circular No. 134. Walworth Co. See page 181.
Circle R10 on postcard.

FORGED STEEL FITTINGS—Literature. Watson-Stillman Fittings Division, H. K. Porter Company, Inc. See page 25.
Circle S2 on postcard.

ENGINE-COMPRESSORS—Bulletin S-500-B23B. Worthington Corp. See pages 12-13.
Circle S4 on postcard.

STEAM TURBINES—Bulletin 1966. Worthington Corp. See page 14.
Circle S5 on postcard.

STEAM TRAPS—Bulletin T-1740. Yarnall-Waring Company. See II Cover.
Circle S7 on postcard.

EXPANSION JOINTS AND SERVICES—Bulletin 351. Zallea Brothers. See page 15.
Circle S8 on postcard.

Esso Names Warren Assistant General Purchasing Agent

Bertram A. Warren, who has been associated with Esso Standard Oil Company for more than 30 years in its Purchasing department, has been appointed assistant general purchasing agent. A buyer for the company since 1934, he has also served with the Petroleum Administration for War both as a consultant and as a materials analyst. As a buyer, he specialized in the procurement of oil country steel tubular goods, oil well drilling and production equipment, welding supplies and non-ferrous metal.

Fitch Replaces Fogg as Head Of Cooperative GLF Division

V. A. Fogg, head of the Bulk Fuels division, Cooperative G.L.F. Exchange, has been granted a leave of absence to devote full time to the presidency of Texas City Refining Company. Ronald Fitch, formerly traffic manager of both Bulk Fuels and Farm Supplies divisions, takes over the Bulk Fuels managership. Fogg assumed the presidency of Texas City Refining on a part-time basis in 1950.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

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Phenylmethanesulfonic acid
Tetramethylethylene oxide
Tetramethyl tin
Anthracene-1-carboxylic acid
3,3-Dibromopentane
3-Nitropyridine
Vinylsulfonic acid
2,4,6-Trimethylphenol
Diphenylacetylene
8-Octadecene
para-Iodobenzoyl chloride
4-Ethylpyridine
n-Heptadecyl bromide
Dioctyl amine
3-Amino-2-naphthoic acid
Allylbenzene
1,3-dioxane
ortho-Phthalonitrile
alpha-Pyran

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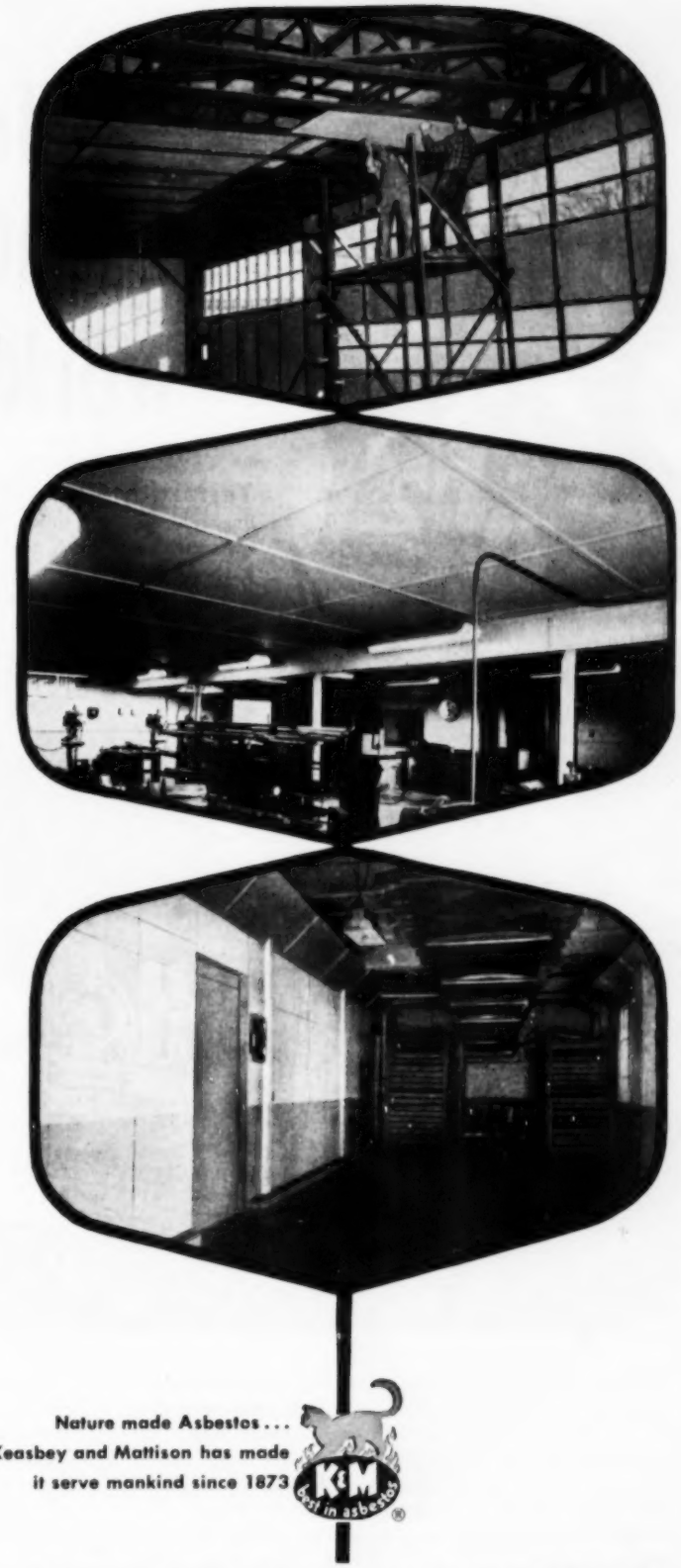

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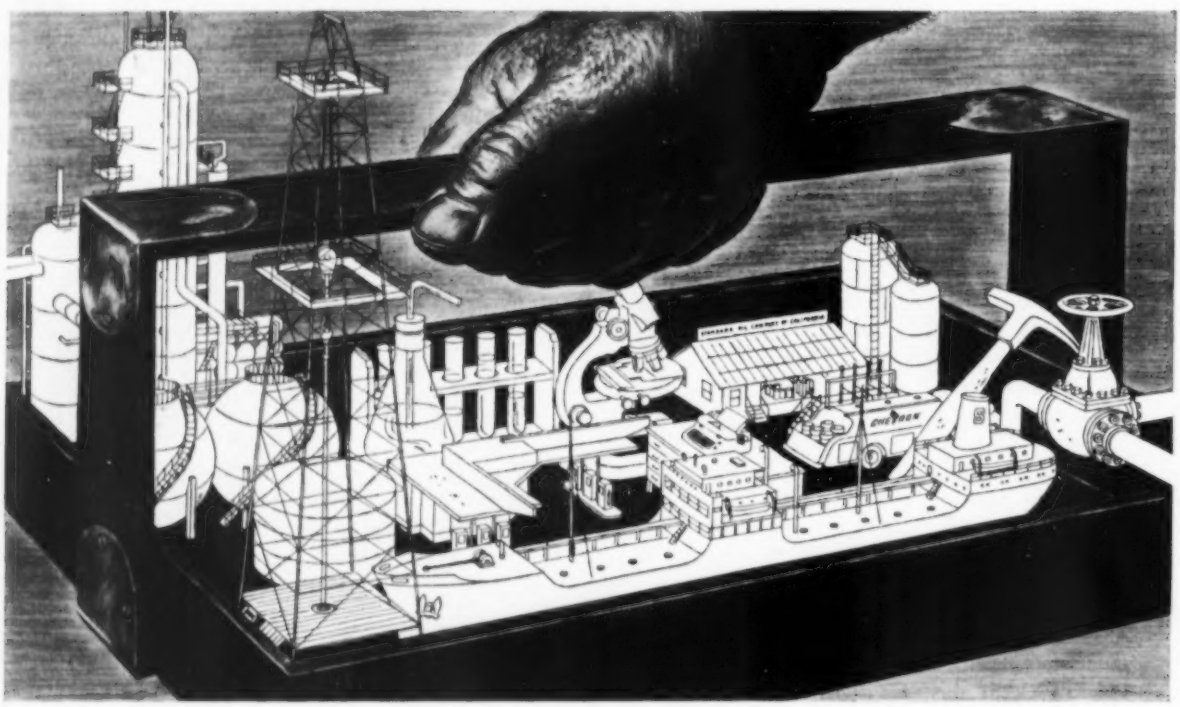

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As **MANAGEMENT** Sees It . . .

How Much Authority Should Safety Directors Have?

VERY LITTLE, They Say

Al Reese,
Petroleum Refiner Staff

How MUCH authority does a safety director need to do his job?

"Not much," declared industry safety experts in reply to a PETROLEUM REFINER questionnaire.

Should a safety engineer have the authority to penalize a worker for persistent infractions of the rules?

"Absolutely not!"

Then should he have the authority to recommend punishment?

"Yes," they said—though not so emphatically. And they were very much at odds in replying to this question:

". . . the most effective safety engineers in the oil fields today are the ones that work like hell out in the field instead on sitting on their *(editor's deletion)* in an office fretting because they don't have the authority to do anything."

Should a safety director have the authority to stop unsafe job procedures or to shut down a unit being operated in violation of the safety rules?

Harmony was restored by questions as to whom the safety director should report and whether the safety and fire directors' jobs should be combined in the interest of centralized authority.

Participating in the survey were 28 safety engineers employed by companies predominantly engaged in refining. All 28 returned a ringing "No!" when asked whether they should have the authority to penalize a worker. Persisting, the survey asked if they should have the authority to recommend punishment. Some indecision was indicated by the 21 affirmative and seven negative answers.

"I find," said one, "that men usually have all the authority they have exhibited the ability to exercise."

Two Bosses? No!

Another opined: "It is rarely possible for an individual or a group of individuals to serve two bosses, so giving a safety director authority over personnel is providing him with a means of creating conflict even with the highest official in the organization. Conflict of this nature will destroy the prestige of line supervisors and the effectiveness of the accident prevention program."

"A safety engineer," said one outspoken participant in the survey, "is a staff man and should not have any authority to fire, stop jobs, etc., without going through regular channels. The good safety engineer gets things accomplished through having the respect of management and employes alike. If the word gets out that he can get a man fired, then the employes and the lower echelon of management will not call things to his attention that he needs to know about.

"In my opinion the most terrible thing that could happen to the average safety engineer would be for him to get too much authority. In most instances . . . the safety engineer would start being about as ineffective as most police departments are in obliterating crime.

"In my opinion the really effective, or the most effective, safety engineers in the oil fields today are the ones that work like hell out in the field instead of sitting on their *(editor's deletion)* in an office fretting because they don't have the authority to do anything.

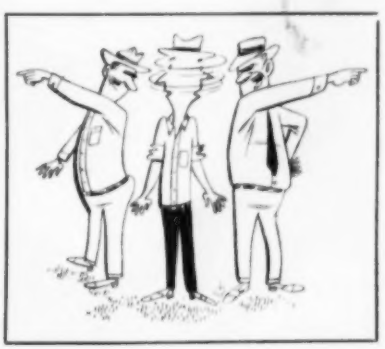
"Again . . . the safety engineer's authority is derived from absolute respect from the pumper to the president."

". . . the line of communications should be as direct as possible with management . . ."

This opinion is represented of those surveyed—but with one point excepted. That is the matter of whether a safety engineer should have the authority to stop unsafe job procedures or to shut down a unit being operated in violation of the safety rules. Ten thought they should have this authority, 10 said not, and 8 said only in emergencies.

One of those who believe he should have this authority declared: "The safety director should be empowered to stop unsafe job procedures and direct the shutdown of operating units if serious hazards exist. In all cases the safety man must be reasonable and right so that he will have the respect and confidence of his management. Thus, his associates will be receptive to his requests."

Among those who disagree, one said: "No. He should work through



"It is rarely possible for an individual or a group of individuals to serve two bosses, so giving a safety director authority over personnel is providing him with a means of creating conflict even with the highest official in the organization."

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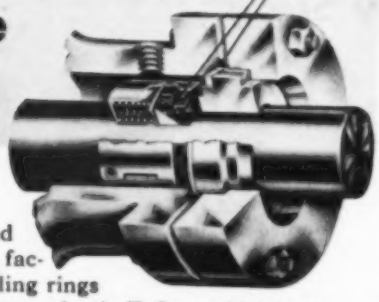

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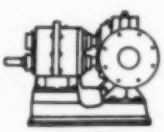

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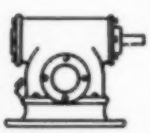

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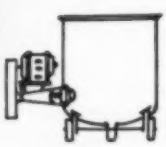

MIXERS AGITATORS

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As **Management** Sees It . . .

line officials or supervisors."

The difference in the executive structure of the various companies prevented a clear-cut analysis of opinion on the matter of to whom a safety engineer should report. However, most said there should be free communication with an executive who has the authority and inclination to act decisively and promptly. "The line of communication," said one, "should be as direct as possible with management in order to (a) impress and demonstrate management's interest in the safety of the personnel; (b) to keep management well informed on matters of fire and safety; and (c) to lend the same prestige to the Fire and Safety department as to other operating and maintenance departments."

Another declared that "The safety director should report to the official heading the staff branch of the organization. If staff and line are headed by one individual, safety should report to him, regardless of title."

"I like safety to be part of the industrial relations department," declared another, "but it can be effective under any top executive except the Engineering department."

Wouldn't Mix Them

One participant said safety should not be connected with industrial relations. "No safety director or safety engineer should report to the industrial relations supervisor. Settling labor disputes with one hand and selling safety with the other won't get the job done."

Five of the participants said the safety engineer should report to the top man, 3 said to the industrial relations chief, 9 said to the top line man in the area, 1 said to the top staff man, 9 thought that anybody at the executive level is satisfactory, and 1 said it is unimportant if management is sincerely interested in promoting safety.

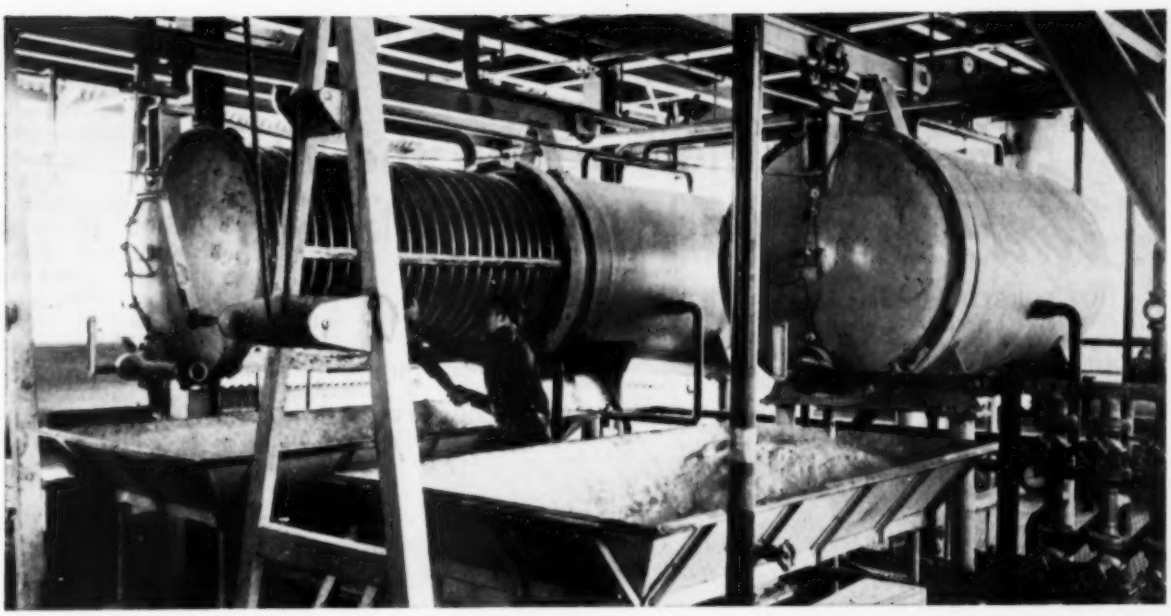
The survey contained one other question: Should the fire and safety directors' jobs be combined in the interest of centralized authority:

"Yes," answered 20. One thought not, 6 said not necessarily, and 1 said only in small plants.

"Fire prevention and safety of personnel," one declared, "are synonymous to the preservation of life and property; therefore, the duties of the safety director should combine all activities necessary to accomplish these purposes. Much duplication can be eliminated by a single administration of fire and safety responsibility."

But another replied: "Fires are ac-

• See AUTHORITY, page 201



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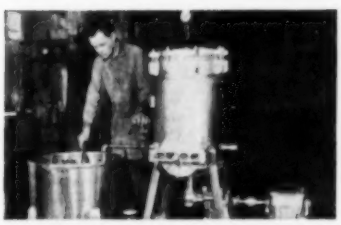

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As **MANAGEMENT** Sees It . . .

The Foreman, the Worker And Human Relations

Carrying out policy and maintaining production schedules are secondary to ability to lead men.

David F. Tver, Director Industrial Relations, Anderson-Prichard Oil Corporation, Oklahoma City

THE FUNCTIONS of the foreman are not limited to carrying out policy and maintaining production schedules. The ability to lead men is one of his most important factors in the successful fulfillment of his job. No responsibility of the foreman is more important than good human relations on the job. He is the main, and, to a large degree, the only contact between management and the worker. He is the one who interprets management's policies and sees that they are carried out, and who most directly affects the morale and loyalty of the worker. As the representative of management, he interprets and administers company policy. He must see that others carry his plans into effect and adhere to the procedures, standards, and safety precautions that have been established. To do this, he must have a knowledge of people.

He must understand what makes them do what they do, and how to handle them as individuals. To achieve satisfactory results, he must have a smooth-functioning unit through the creation of loyalty, pride in accomplishment, and enthusiasm for the work.

The foreman in turn must be understood by those who supervise him. His thoughts toward his job, his status in the organization, his capabilities, and limitations must all be considered in order that he be properly evaluated by those above him. The foreman brings his entire personality to his work. Domestic problems are not left at home; his worries and fears, weaknesses and strengths are a part of him. He is the product of environmental, biological, and social forces which have made him what he is. Whether he has the capabilities to succeed depends upon the sum total of all these factors.

His problems should also be understood. Most of the foremen are selected from among the ranks of the workers. He has been one of them for a number of years, working beside them and mingling socially and in recreational activities. When he is promoted, he finds himself in charge of his former associates, responsible for their work; and he is expected to represent management to them, and represent them to management. He is faced with dual loyalties to which he finds it difficult to reconcile himself. Former friendships are likely to become strained because of his new duties; and jealousies will sometime arise in workers who consider themselves equally well qualified and do not understand why they were bypassed. These pressures do not make his job easy.

Feels Neglected

His position normally is at the bottom of the management level; and because of this, he often feels that he is neglected. In most instances he feels he rarely participates in the making of decisions or the determination of policy, and often does not know the why's and wherefore's of such decisions. All he knows is that management has made such a decision and that he is expected to put the decision into effect. It is because of this that the foreman often has difficulty in identifying himself completely with management. Yet he occupies a unique place in the company structure. He is the only part of management that can build the organization of the rank-and-file people and who knows the employes

intimately enough to deal with them on a personal basis. He alone can obtain the degree of cooperation necessary for maximum production, and such cooperation can only be found where satisfactory human relations exist.

The key to any successful group relations lies in the leader's ability to handle and guide his group satisfactorily. Unless the foreman himself is a stable person, he cannot expect to have the stability of those he supervises.

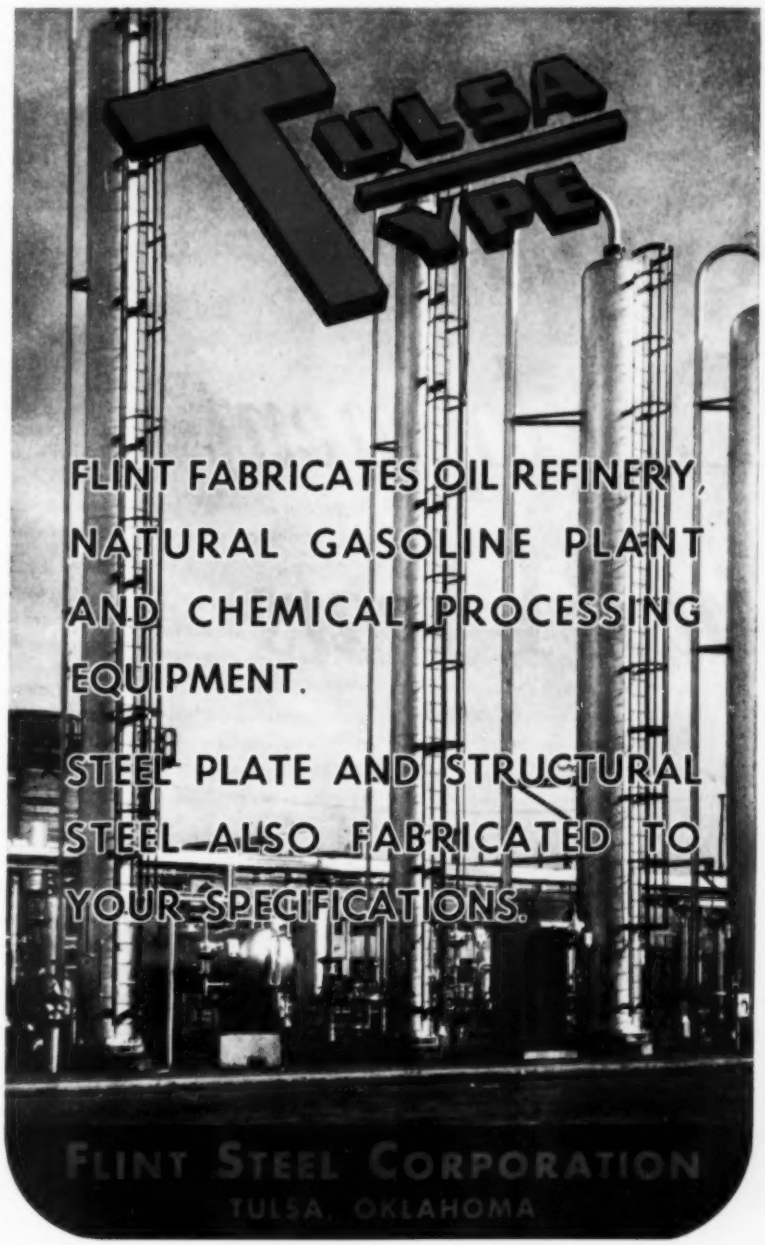
In many instances absenteeism and emotional disturbances of employes can be traced to improper supervision. When an employe says, "that foreman gives me a pain in the neck," he is usually exercising a figure of speech; but sometimes the "pain in the neck" is an actuality stemming from emotional tension and antagonism caused by the employe's inability to adjust. Emotional upset plays a significant role in physical complaints. A foreman should be trained to understand human behavior so that he will understand the underlying meaning of complaints and grievances. To understand a complaint, it is necessary to understand what the complainant is really talking about—what is really on his mind. Understanding and diagnosis is a major problem in dealing with these complaints. If a worker complains his tools are defective, when his real trouble is that his foreman is riding him too hard, it does little good to prove to him his tools are in good shape.

Often complaints about the most obvious of external conditions may be indicative of some disturbance of the individual. The individual who is satisfied with his job and his life in general tends to accept things which to another may seem intolerable. He may take for granted dirty surroundings, poor tools, or other conditions as long as they do not symbolize inadequacies or frustrations in his adjustment, either at work or outside. But the frustrated worker may complain about these same conditions which the other worker takes for granted as part of the work situation. For this reason it is important to treat complaints as symptoms; and even though the thing complained about can be, and is, corrected, it should be assumed that the complainant might have underlying factors generating these complaints. In a sense, the foreman himself can start these complaints. The foreman may be an able man; but he is in a difficult position. His simplest criticism of error, when handling a workman, may release an accumulation of feeling or action that is wholly out of proportion to the seriousness of the foreman's offense.

A company is affected to the degree that such complaints interfere with productivity. In the period ahead of keen industrial competition, the factor of human emotions in the plant may be meaningful in terms of profit and loss through loss of production, unnecessary strikes, and intentional slowdowns.

When interrelationships between the foreman and the worker are good, people have confidence in themselves and a desire for accomplishment. Poor interrelationships undermine production. Any attempt to build morale that does not start with improving foreman-employe relations is fully a waste of effort.

Let's examine the employe's position. When he is doing the work he likes best, he is happy; work or job satisfaction is the principal media for realizing happiness. No man has to work in an atmosphere that is a mixture of suspicion, fear, hate, unfairness, or other unpleasantness. If he doesn't leave the company, it may drive him to excel outside of the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With the advent of high octane number fuels for peak performance of both military and civil aircraft, the problem of spark plug fouling became critical. Maximum design performance and range of the aircraft were severely limited by deposits formed on the insulating portions of the spark plugs. These deposits caused malfunctioning of the spark plug often at critical times when maximum spark plug performance was necessary. The problem was studied jointly by petroleum suppliers, engine and spark plug manufacturers, and airframe builders both from the chemical and mechanical standpoint.

Shell Research Mobilized

To tackle the problem Shell mobilized its research facilities. First step was development of a dependable test for spark plug fouling. With this test, Shell had the necessary equipment with which hundreds of compounds could be quickly tested—rejected and tested again in different formulations. Round-the-clock testing finally led to the discovery of Shell's TCP additive.

Not since the introduction of tetraethyl lead in 1922 has there been such an important development in gasoline.

How TCP additive helps existing engines—can lead to even better designs

This remarkable ingredient actually changes the nature of combustion deposits inside an engine; actually makes them harmless. Plug-shorting and pre-ignition are eliminated. Now car owners get up to 15% more power—often before using the second tankful. Spark plug life is increased as much as 150%, and gasoline mileage is improved.

Car manufacturers and dealers benefit too! New cars perform the way designers intended; new car buyers have few performance complaints. And for the future, designers can plan for higher compression and horsepower, lighter and more compact engine designs.

TCP is Shell's trademark for this additive. It is another example of the progressive research that goes forward day and night in Shell laboratories. It is evidence again that Shell research provides more and better products from petroleum.

*Patent applied for

SHELL OIL COMPANY

SHELL

company in various ways as social activities, hobbies, etc. No person will exert his utmost capabilities unless he is motivated. This in a way creates a challenge to the supervisor. Can a man's job be made so interesting and inviting that he hates to leave it when the whistle blows?

Individuality Lost

This is not an easy question to answer because of other social and economic factors that affect the overall picture. As companies have grown larger, the personal relationship of the individual has been lost in the masses and his job, through mechanization, has become routine or monotonous in nature. This is also true of refinery operations. Work in the refinery normally is hard or dirty labor, and, with the exception of the draftsman, routine. Under union contracts normal progression is based upon strict bidding and seniority. Initiative and aggressiveness is secondary to waiting the required length of time for promotion. There is also the added factor that there is little creativeness involved to instill pride of accomplishment. A workman in a refinery is normally engaged by an employer to do a certain amount of work, under certain conditions, for so many hours, for so much money. The item of trust and mutual welfare is largely ignored because of such intermediary factors as union bargaining and representation. For the vast majority of workers, there is no relation between interest in work, enthusiasm, the amount of work they do, and their rewards. Individuality has become lost in agreements between unions and employers.

It is these and many other factors that have a direct effect upon any discussion involving morale. There is no formula or panacea to eliminate these factors; however, the foreman's ability to know and understand people will go far in lessening the impact of these forces. Supervision must motivate people to close the gap between what they are and what they can be. It must bring out the natural drive which is inherent in every worker and furnish the proper incentive and motivation.

Working with people produces a certain intimacy that is important in producing group pride. Unless a supervisor has a certain amount of intimacy with his associates, he cannot do a complete job. Yet he cannot mix this with familiarity. A discreet amount of intimacy is desirable, though it need not lead to sacrificing of dignity to loose familarity.

This factor is tied into group loyalty

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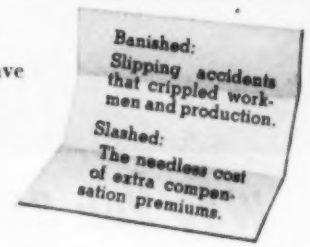
"Fall Guys" was the name men gave themselves in the drum-filling room of a southwestern refinery. For the oil-splashed floor was treacherous underfoot—and crippling falls were frequent.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very closely. In a large company, the individual is lost in its largeness and its complexities. The group's first and important contact is the foreman, who can develop competitive group loyalty. It is here that the worker best understands the meaning of belonging. Here is where he sees the results of his efforts, where he receives the praise and pride of accomplishment.

Group Pride

Group pride is the key to successful productivity. The foreman begins his art of handling people with each new employe. The employe is introduced to his fellow workers, is given complete instructions, and encouraged to believe that he is becoming an accepted member of the group. The foreman aids the new employe by this method to acquire the "feeling of belongingness," which psychologists have found important in social adjustment. Friendly rivalry between production units often leads to group pride also, which increases individual self-respect and ambition. A person thinks more highly of himself if he belongs to a group of which he is proud. A newcomer to a group will be proud of his work group only if a high morale already exists.

High morale among both veterans and newcomers is built through just dealings with all persons in an organization, through a contagious example of sincerity and self-sacrifice set by the leaders, and through a desire on their part to teach others to participate more fully in the responsible business of planning production and maintaining high morale and efficiency in every phase of their work.

A foreman normally is promoted from the ranks. In most instances the basis for promotion is his mechanical skill and efficiency, with little regard for leadership ability. Up to the time of promotion he has had little experience in a supervisory capacity. The fact that a person is a good mechanic does not guarantee that he knows how to handle people. Then, after he is chosen, little is done to teach him how to manage people. Few supervisors are aware that their leadership is deficient or realize that their concepts on producing efficiency can, in reality, reduce it.

Homer E. Lunken of the Lunkenheimer Company of Cincinnati, in an address before the American Management Personnel Conference, stated:

> "Many are inclined to look with favor on the meticulous supervisor who keeps in close touch with the various details of the jobs being performed in his department, who

provides detailed supervision of the work being done and the manner in which it is performed. The research findings in this study indicate, however, that this type of supervision doesn't tend to produce the results expected of it. As a matter of fact, employes in low production sections are under more detailed supervision, whereas employes in high producing sections receive only general supervision."

A new foreman's approach to his personnel problems usually is the manner in which he himself has received instructions from his former foreman, since that was his only contact with supervisory practices. His training up to this time has been for mechanical and skill proficiency only.

Deal With Personalities Now

In the transition from handling machines to handling people, there is an additional knowledge required of dealing with personalities and emotions and the realization of their influence on behavior. A person who has not faced these problems and who is not aware of them finds certain difficulties which he cannot understand. He does not realize that the principal cause of his difficulties may lie in himself. Because he may project the responsibility for the trouble on to the employe, the employe may become uncooperative, insubordinate, and the trouble is then automatically assumed to lie with the worker. A position of leadership involves more than being a boss. It involves having a knowledge of human beings and a sensitivity to social relations that assures both the worker and foreman of a certain degree of security.

It is because of the fact that little attention is given to the development of foremen from the working group until an actual vacancy exists that problems in leadership arise. As C. F. Mugride points out in his article, "The Job and the Man":

"Consider for a moment the common method of appointment to the lower management group. It is shamefully ludricious. Usually it takes place after a frantic meeting in which somebody decides a department needs more supervision. Several of the best workers are selected as candidates. Job knowledge is always the first requisite; in some plants, seniority comes first. After some discussion, which may disclose that none of the candidates is suitable, one is chosen. Today a worker; tomorrow a manager. Little wonder that so many flagrant violations of the laws of good manage-

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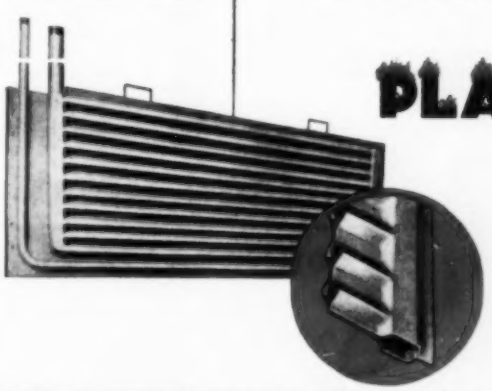

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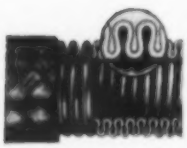
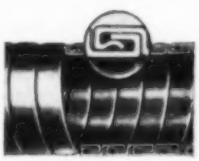


CMH corrugated hose is available with metal braid covering or unbraided in steel, bronze or stainless steel. Used where great flexibility is required at high temperatures and high pressures. Sizes range from 3/16" I.D. to 24" I.D. Depending on size, type and material, it will handle burst pressures to 12,000 psi, temperatures to 1200° F.

CMH interlocked hose is available in various types, packed and unpacked, in steel, stainless steel, bronze, aluminum, brass and other metals. It is used for steam, exhaust, tar and asphalt, etc. Sizes ½" to 12", I.D. Depending on size, type and material, it may be used for working pressures to 750 psi (constant), temperatures to 600° F.

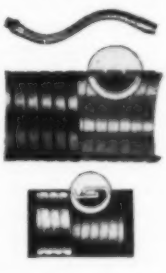


CMH double groove (ball bearing design) hose is available in bronze, steel or stainless steel with asbestos packing and with or without metal braid covering. Widely used for non-searching liquids and gases at low to moderate pressures and temperatures. Sizes range from 5/16" to 1¼", I.D.

CMH square locked hose is available unpacked or with a choice of several types of packing in steel, bronze, brass, aluminum, stainless steel, etc. It is used as conduit, cable armor, nozzles and many similar applications. Sizes range from 3/16" to 1", I.D. Normally used only at very low pressures.

For full information on all CMH hose products write for Catalog 130 or see the Flexonics catalogs in Sweet's Plant Engineering File, Chemical Engineering Catalog and The Refinery Catalog. For maintenance hose, see the classified pages of your telephone directory for the name of your CMH distributor.

Standard assemblies and special purpose flexible metal hose items are manufactured for such services as steam, tar and asphalt, machine tool coolants, machine tool wiring conduit, dry granular products. We will be pleased to send data on any specific requirement.



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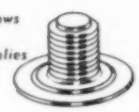

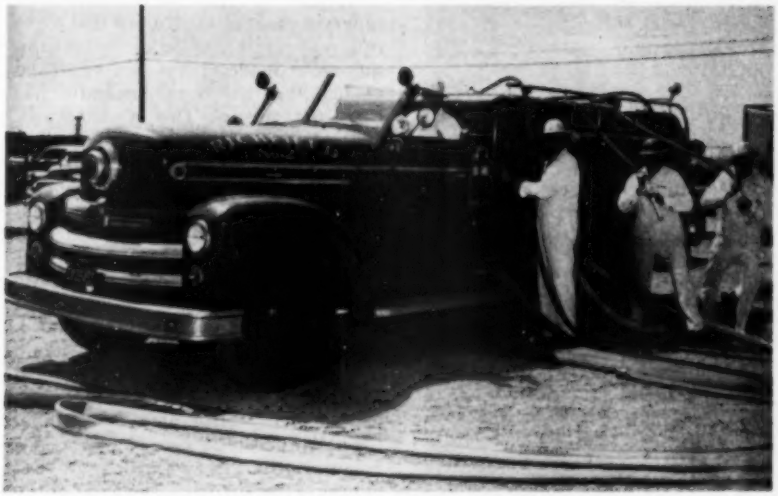

Truck Fights Fires Three Ways—

A fire truck equipped with three different fire-fighting mechanisms has been put in service at the Richfield Oil Corporation refinery in Wilmington, Calif.

One mechanism utilizes a 2000-pound dry chemical tank from which four hose lines spray a compound of sodium bicarbonate and other chemicals at the rate of 1300 pounds per minute.

Supplementing the dry chemical tank is an 800-gallon tank filled with high-expansion liquid foam, and a water pump powered by a 285-horsepower engine and capable of pumping 2800 gallons of water per minute through eight additional hose lines. The foam mixed with water smothers flames on horizontal surfaces. Water can also be used separately as a cooling agent to prevent gas and oil fires from spreading.

The truck weighs 30,600 pounds, fully loaded.

ment are committed. For not even an exceptional person can successfully stand up against the many and complicated business problems of today without training. Think of the results when the appointee does not even possess potential ability."

Another point to be considered in this type of forceful decision is that selection is narrowed down by many factors. A person may have all the attributes for successful leadership, but may not want to assume the responsibility.

There are many who, for one reason or another, are unwilling to accept the responsibility of being a foreman. Some may not want to move out of the social organization to which they belong as workers, because they would have to assume responsibilities that would alter their entire interpersonal relations with their fellow workers. To some people, this would be a sacrifice not commensurate with the benefits to be gained. There are others who become mentally depressed by responsibility and cannot accept such a position without impairing their precarious mental balance upon which their adjustment has been made, and who are living satisfactorily under such adjustment. There are those who have too much or too little regard for authority. Then there are others who cannot accept responsibility because they are basically immature and have never learned to accept or assume responsibilities other than the minimum need. These people, despite their knowledge of the requirements of the job, are not equal to the task of managing others and getting the necessary cooperation from them. These people, because of their own pecularities, can readily create tense situations in an organization and transform normally competent employees into problem cases. In other words, willingness to accept responsibility, while varying from person to person, must be developed by a gradual process to the extent that the individual comes to accept it with maturity and confidence.

Planning Needed

These are but a few of the so-called byproducts of thought that are necessary in developing a sound approach to supervisory selection. There has been a lack of planned and substance programs in lower management groups in industry that seek to develop the foreman in human relations. More thought is needed in the de-

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As **Management** Sees It . . .

velopment of potential foremen and supervisors. It is recognized that there is no one single method of recognizing successful leaders; but one approved method that has been successful has been the use of the understudy method. That is, having an understudy for every foreman and studying the individual to determine his ability to assume the foreman's job in event of a vacancy. It is recognized that there could be adverse results; as those going under this training with the expectation that promotion will result, and then become disillusioned. However, the training itself should be handled on the basis of a clinical approach; and no one should be encouraged to participate who might logically never be chosen for such a responsibility. In a process of this nature, it would be possible to eliminate through observation and employe self-evaluation many who might have to be eliminated through the trial-and-error method. In the trial-and-error method, an excellent mechanic might be lost because of his inability to assume the necessary responsibilities; one who might not have accepted the position had he had advanced knowledge of the position requirements and his personal evaluation of his ability to do the job.

In examining the many supervisory and foreman training programs that have been developed, it appeared that the human relations aspect was either neglected or lightly dwelled upon. Little significance was given to the emotional problems that would have to be met by the foreman. There was no particular importance attached to the relationship between productivity and morale. Since morale is a loose word and cannot be measured in terms of productive units or placed on a technical graph, the tendency is to simply ignore its existence until such time as it manifests itself in terms of grievances, increased absenteeism, lower production, or general inertia.

World War II pointed the need and started the development of some excellent programs in supervisory training.

The Johnson and Johnson Company's supervisory training program stresses four principal areas; human relation skills, administration skills, company information, and technical skills.

The objective of the company's training is to accomplish the following results:

- To make supervisors more efficient.
- To increase their understanding

of the part human relations plays in supervision.

- To give supervisors a better understanding of their responsibilities and ways to meet them.
- To give supervisors a broader understanding of the company's business in order to arouse interest in loyalty and encourage initiative in work.
- To lay the basis for uniform interpretation of managerial policies throughout the organization.
- To acquaint supervisors with the problems of top management.
- To encourage supervisors to plan and undertake a continuous program of self-improvement, growth, and development.
- To prepare supervisors for more responsible positions by proper training and experience.

Shell Oil Company's training publication, "The Supervisor's Place in Management," appears to also stress the importance of the human factor. One of the basic points the outline pursues is the recognition of the human factors in getting the work done. The following is quoted from the manual:

> "The application of good human relations on the job is an essential phase of the supervisory function. The proper performance of any job depends on its adaptation of the circumstances and personalities concerned. Human factors are probably responsible for most of the problems; human shortcomings are usually responsible for the interruptions in any properly organized chain of communications . . . In the give and take of daily work, relationships are not always smooth and unruffled. Because of the close contact between the supervisor and work force, and supervisor and boss, human weaknesses are all the more apparent. It is difficult for us to form personal reactions, either favorable or unfavorable, toward persons we see only occasionally and with whom we have little direct contact. A number of factors, such as personal problems or physical conditions, can affect the job performance of each of us. We should make reasonable allowance for the effect of these factors in others, just as we would like others to minimize some of our own personal shortcomings."

Psychologists have made many studies concerning the requirements of good leaders, causes of satisfaction and dissatisfaction among workers, and productivity in relation to employe morale. Regardless of which

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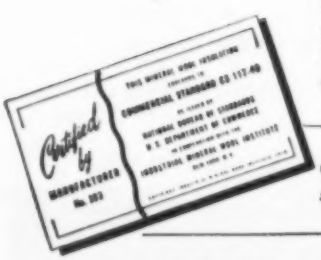

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As **MANAGEMENT** Sees It . . .

Editor's Note: *It is axiomatic in the petroleum industry that accidents seldom happen to experienced workers on hazardous jobs. It is the easy routine task that invites carelessness and causes injuries. This is the first of a series of pictorial safety messages taken directly from the accident experiences of refineries and natural gasoline plants. Only the names of the persons and companies involved will be omitted. Clip them. Put them on your bulletin board. Drive home the warning that IT'S EASY TO GET HURT.*

The Accident: Distilling unit was out of operation for cleanout and general repairs. Cables and snatch blocks had been installed to remove equipment at the only passageway under the steel structure. One of these cables was located about two feet off the ground with a snatch block attached to remove the exchangers after they had been lowered to the ground. A workman walking through the passageway looked up to see if a load was suspended overhead. He tripped over the cable and fell, injuring the semilunar cartilage of his left knee.

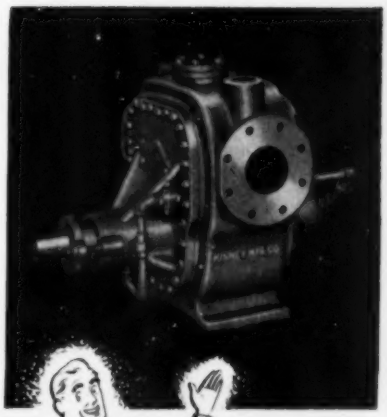
Recommendation: This accident was caused by haste and inattention. Workman could have avoided this passageway; but it was the noon hour and he was hurrying to his lunch.

survey, the general results invariably indicated the quality of leadership at the foreman or supervisory level determined the attitude of the worker toward his job. He, rather than any other executive or official of the company, influenced attitudes by his personality, mannerisms, ability, and personal leadership. Unless this group is trained in the management of people, no amount of employe benefits will give the returns in cooperation of maximum effort that is so necessary for a company in order to operate economically and successfully.

AUTHORITY—

(Continued from page 188)

cidents, so why not incorporate fire protection training in the accident prevention program? The safety director should not be placed in charge of fire-fighting. This is a line supervisor's job."



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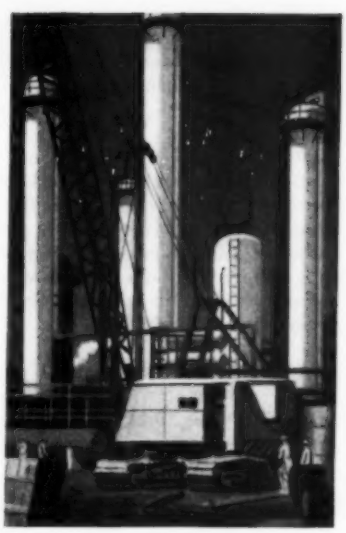
Celanese Corporation's integration program embraces affiliates in Europe, the Orient, Latin America, and extensive expansion of already vast operations in Canada and the United States.

On the domestic front, Celanese is enlarging its scope in the production of raw materials for the chemical, plastics and petrochemical fields, and developing fibers to put new emphasis on industrial synthetics.

Brown & Root feels signally honored to have been selected to design, engineer, and construct plants in three different nations, for Celanese Corporation of America. This is another example of the greatest names in American industry benefiting from Brown & Root's extensive experience in process engineering and construction.



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WHO'S Building . . .

• CONTINUED FROM PAGE 95

a year. Acquisition of the site is part of a long-range expansion program; construction will not likely be undertaken until existing refineries have been enlarged.

The company has also had under consideration a site in the Goodwin Neck section of York County. The company said the West Norfolk location had been selected because of physical and economic factors.

Warren Gasoline Unit Slated For Next February Completion

Construction of Warren Petroleum Corporation's Saunders natural gasoline plant, located approximately 17 miles northwest of Lovington, N. M., has begun, and completion has been set for February, 1954. The Fluor Corporation, Ltd., has the contract to construct the plant.

The initial installation will include facilities to gather and process approximately 22 Mmcf. of gas daily, with a daily average production of 30,000 gallons of natural gasoline, 15,000 gallons of butanes, 31,000 gallons of propane. Approximately 16 Mmcf. of residue gas will be delivered to a gas transmission pipe line network.

The Saunders plant will recover the light hydrocarbons as a mixture which will be pumped through a 35-mile pipe line to the corporation's Monument, N. M., plant for final separation and processing.

Work Starts on Plant to Make Platinum-Content Catalyst

Baker & Company, a member of the Engelhard Industries group, has started construction of a plant to produce a new platinum-containing catalyst for use in reforming petroleum. When completed and equipped, the plant will represent an investment of $2.5 million. Being built on a ten-acre tract in Newark, N. J., the building will provide 58,000 square feet in a single story.

The catalyst to be produced is the result of joint research by Sinclair Research Laboratories, Inc., a subsidiary of Sinclair Oil Corporation, and the research laboratories of Baker & Company. It will be known as Sinclair-Baker Catalyst RD-150.

The new plant was designed by Slocum Engineering Company and is being built by Di Girolamo Construction Company. It will start operating early in 1954.

Certificate Granted Texaco On New Jersey Refinery Units

The Texas Company has been granted a certificate of necessity to cover the $12.5 million cost of constructing two new processing units at the company's Westville, N. J., refinery.

Plans call for the construction of a 10,000-barrel-a-day Platforming unit and a sulfuric acid alkylation plant capable of producing 1500 barrels a day of aviation alkylate. Also, additions to tankage and utilities are planned.

The project will be the first major addition to the 60,000-barrel-a-day refinery since it was completed in 1949.

Deep Rock Continues Cushing Expansion—

All phases of operation are automatically controlled in the new $2.5 million solvent lubricating oil plant recently completed at Deep Rock Oil Corporation's Cushing, Okla., refinery. The new plant, now in operation, is the latest in a sizeable expansion program at the refinery.

Other major projects completed since the expansion was launched in 1949 include a catalytic cracking unit, a new crude unit and a streamlined blending and packaging plant. The new units have increased the daily crude intake from 12,400 barrels a day in 1948 to the recent rate of 19,000 barrels a day. The additions have also modernized the plant and improved the quality of the products.

The solvent plant was designed and constructed by The M. W. Kellogg Company. The Refinery Engineering Company built the auxiliary facilities.

1500-Barrel Refinery Planned By Williston Basin Refining

Williston Basin Refining Company has announced plans to erect a 1500-barrel-a-day refinery on the edge of Williston, N. Dak. The company was recently formed by a Williston group headed by R. Mowdy, who is now president of the company.

Facilities of the plant will include an undetermined type of catalytic reforming, gas recovery, utilities, tankage, and other installations for a complete refinery. Koch Engineering Company, Wichita, Kan., is the engineering contractor.

Carthage Hydrocol to Reopen Brownsville Synthetic Plant

Closed recently because of its inability to reach capacity output, Carthage Hydrocol Company's Brownsville, Texas, plant will be reopened as soon as needed repairs are made. The plant had been closed "indefinitely."

The $40 million project produces gasoline and chemicals from natural gas. No date has been set for the reopening, but the firm plans to rush work as fast as possible. It reported that if all the needed equipment were on hand, "it would take about three months to install."

The plant was designed to produce about 6000 barrels a day of synthetic gasoline, 900 barrels of gas oil, 200 barrels of fuel oil and 300,000 pounds of water-soluble oxygenated chemicals.

General Petroleum to Build Thermofor Catalytic Reformer

Ground has been broken at General Petroleum Corporation's Torrance, Calif., refinery for a new type processing unit which will make possible increased production of "very high octane gasoline." Known as "thermofor catalytic reformer" (TCR), the new process is a continuous method of upgrading low quality gasoline stock to a gasoline which, with the addition of tetraethyl lead, will have an octane number of 100 or more. Scheduled for July, 1954, completion, the unit will produce about 15,000 barrels a day of high quality gasoline blending stock.

Construction of the $9 million unit will be under the supervision of C. M. Reading, General Petroleum's Engineering department manager, and Howard Rustad, acting as construction engineer. Bechtel Corporation is the contractor.

Danaho Plans to Increase Capacity of Pettus Refinery

Capacity of Danaho Refining Company's 5000-barrel-a-day Pettus, Texas, refinery will be increased to 8500 barrels a day. The company also plans to install a nominal 5000-barrel-a-day type 17 thermofor catalytic cracking unit with concurrent reforming and gas concentration.

Also involved in the plans are capacity increases for existing catalytic polymerization and plant utilities. Contracts have not yet been let for engineering and

WHO'S Building . . .

construction, but it is hoped that the $2,670,000 expansion program, for which certificates of necessity and rapid tax amortization have been granted, will be completed by August, 1954.

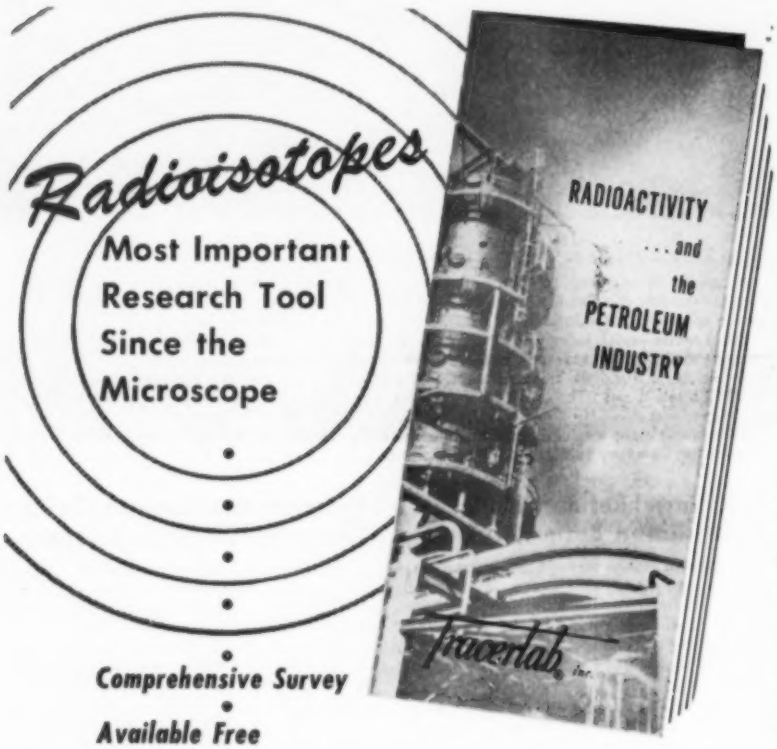
Quaker State Refinery Closed

Quaker State Oil Refining Corporation has shut down its Oil City, Pa., refinery for an indefinite period. Company officials said the order was necessitated by low wholesale prices for lubricating oils and loss of export markets. The 70-year-old refinery has a crude charge capacity of 2800 barrels a day.

Ingram Products Modernizing Former Gilcrease Oil Refinery

The former Gilcrease Oil Company refinery at Meraux, La., is being reopened by Ingram Products Company with a $4 million expansion and modernization project. The revamped refinery, which was closed about two and a half years ago, is expected to be in operation by February or March. Improvements include installation of a Platforming unit with a charge capacity of 3500 barrels a day of gas oil, plus gas concentration and vacuum units.

Construction has started with Procon, Inc., in charge. Upon completion, crude capacity will be increased to an estimated 7000 barrels a day.



Tracerlab recently compiled and published a 16-page brochure which surveys most of the known applications of radioactivity in the petroleum industry. Presented in clear, down-to-earth, non-technical language are the facts about isotope use in your industry that you should know. Also included is a valuable three-page bibliography.

This comprehensive booklet was prepared to provide a stimulus to the present users of isotopes to develop new applications, and to acquaint non-users with what has been happening in this highly important new field. Radioisotopes and their unique properties, acknowledged to be the most important new research tool since the discovery of the microscope, should be known to all research and operating people.

Secondly, "Radioactivity and the Petroleum Industry" is intended to acquaint you with Tracerlab. We pioneered in the field of commercial radioactivity and are now the largest firm in the field. We produce the most complete line of nuclear instruments; sell the largest number of "tagged" compounds; provide the most comprehensive consulting service.

Write on your business letterhead — we'll be glad to send a copy of RADIOACTIVITY and the PETROLEUM INDUSTRY.

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Projects Worth $5.7 Billion Approved by PAD in Two Years

From June 11, 1951 to July 1, 1953, the Petroleum Administration for Defense approved applications to build or complete oil and gas projects valued at $5,785,254,497, according to a recent announcement by Deputy Petroleum Administrator Joseph A. LaFortune.

Applications for approval of facilities valued at another $1,076,314,740 were denied, canceled, deferred or returned without action. This figure was influenced in large measure by the fact that PAD returned a number of cases in the second quarter of 1953 because of the imminent end of the Controlled Materials Plan.

Over a period of little more than two years, a total of 6349 original cases and 2189 amendments were approved. Following are the total values of original cases and amendments approved by each of the PAD divisions:

Gas	$2,392,965,696
Refining	1,619,527,898
Supply and Transportation	1,244,851,953
Natural Gas Production and Processing	437,301,276
Marketing and Distribution	25,895,588
Production	64,712,986

These figures, LaFortune pointed out, do not necessarily cover all of the expansion initiated by the oil and gas industries over the past two years, since some operators did not require priorities assistance for their purchases of construction materials. The totals do, however, provide a rough measure of expansion during the mobilization drive.

Planned Pan American Plant Gets Certificate of Necessity

Pan American Refining Corporation has been issued a certificate of necessity for construction of a 25,000-barrel-a-day refinery on the Delaware River near Pedricktown, N. J.

While the certificate specifies the New Jersey building site, the company has two other possible locations under consideration. One is near Portsmouth, R. I., and the other in Talbot County, Md., on the east shore of Chesapeake Bay. Company officials report that a definite decision on building will not be announced until studies on all the proposed sites have been completed.

Carter Oil Begins Operation Of New Polymerization Unit

A new polymerization unit at The Carter Oil Company's Billings, Mont., refinery has been placed in operation. The unit will increase the high-octane gasoline production of the plant by 27,000 gallons a day.

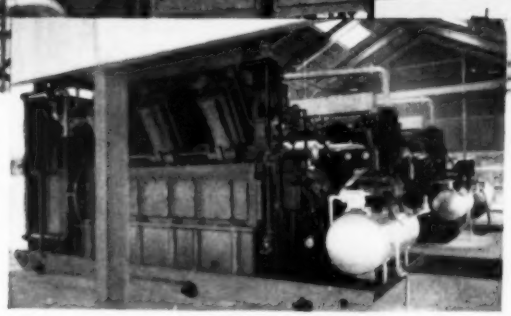
The new Carter refinery, completed and placed in operation in 1949, processes an average of 21,000 barrels of crude daily.

Nitrogen Facilities Planned By Utah Chemical-Monsanto

Utah Chemical Company and Monsanto Chemical Company have planned two new plants for synthesizing nitrogen products from natural gas. Utah Chemical, a newly formed firm in Salt Lake City, has applied for a certificate of neces-

BEAIRD-INGERSOLL-RAND

Packaged Compressor Plant



These three packaged compressor plants are equipped with Ingersoll-Rand 330 h.p. 6SVG gas engine-driven compressors, Young radiators, and all necessary connections and controls. Other sizes from 110 h.p. to 550 h.p.

Oil wells in Turtle Bay Field, Texas, operated by Stanolind Oil and Gas Company, are produced with a rotative gas lift system. Gas within the system is constantly circulated at required pressure and excess gas is delivered to a nearby sale line. For this operation, a compressor station of approximately 1,000 horsepower was required. So a bank of three 330 horsepower Beaird-Ingersoll-Rand packaged compressor plants was installed.

These packaged compressors were delivered to the location as fully assembled units. Each one has all necessary gas piping and manifolds, complete systems for cooling, lubrication and air starting and integral automatic controls. Complete packaging at the Beaird factory reduced field assembly to a minimum, saving weeks of valuable installation time.

Let us tell you about the economies of using Beaird-Ingersoll-Rand packaged compressor plants in multi-unit installations.

Used three packaged units —

HOW TIME WAS SAVED IN INSTALLING A COMPRESSOR STATION

THE J. B. BEAIRD COMPANY, INC.

BEAIRD

SHREVEPORT, LOUISIANA

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FABRICATING

STEEL WAREHOUSE

PACKAGED COMPRESSOR PLANTS

CAST STEEL FITTINGS

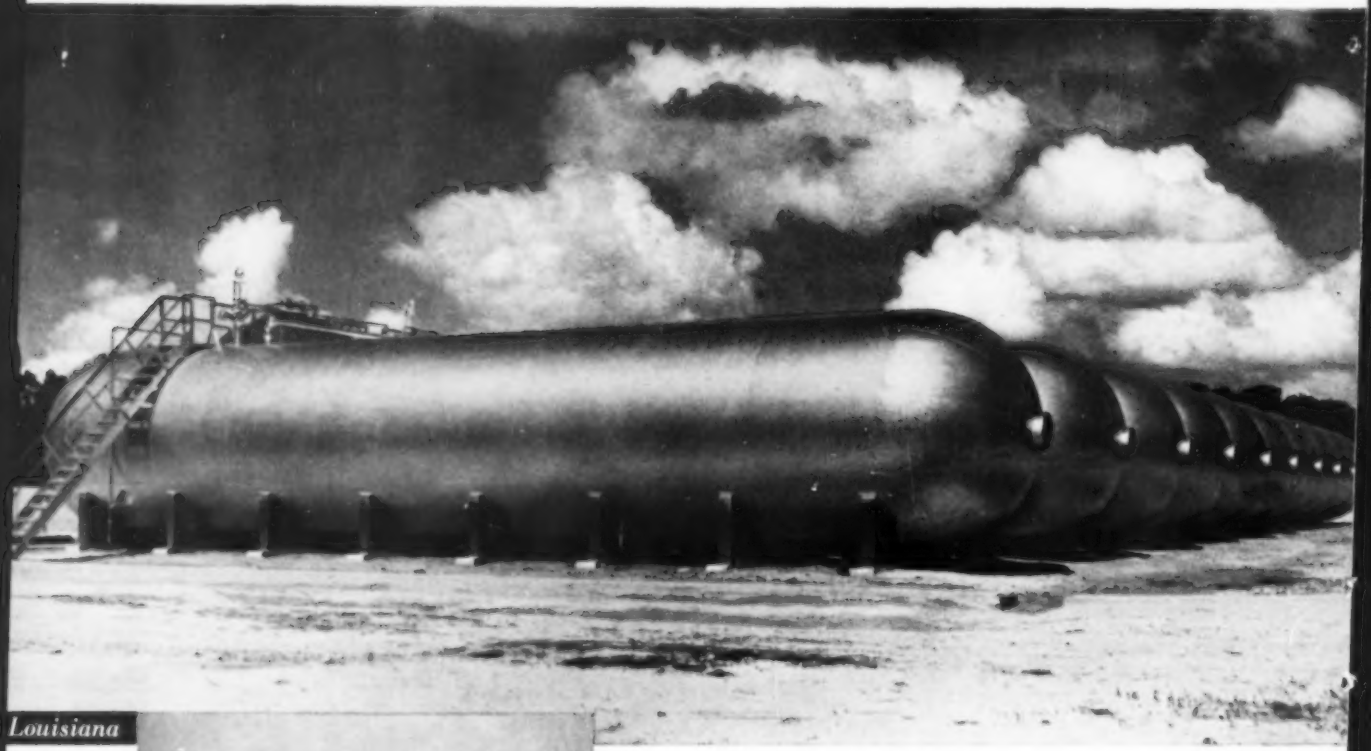
PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

LP-GAS SYSTEMS

Engineered For Safe Storage

BEAIRD PRESSURE STORAGE TANKS

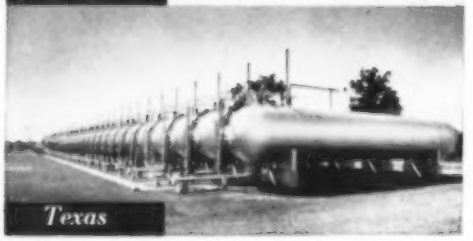


Louisiana

Nebraska

So. Carolina

New Mexico



Texas

All over the Nation

Here are a few of the installations of Beaird pressure storage tanks you'll find throughout the country—and there are many more. For Beaird has been manufacturing pressure storage equipment thirty five years. And during the past five years, Beaird production lines have been averaging one major size tank per day.

This demand for Beaird pressure storage tanks is no accident—it's the result of Beaird's advanced engineering design, constantly improved manufacturing techniques and thorough inspection and testing. That's why the firms which constructed these plants chose Beaird—that's why you too can have complete confidence in pressure tanks manufactured by Beaird.

Let us have the opportunity of discussing your pressure storage requirements with you.

THE J. B. BEAIRD COMPANY, INC.

SHREVEPORT, LOUISIANA

Packaged Compressor Plants

Cast Steel Fittings

BEAIRD

Machining
Fabricating
Steel Warehouse

Pressure Bulk Storage

Anhydrous Ammonia Equipment

LP-Gas Systems

sity for an $18.8 million ammonia plant for the south-central section of Utah. In addition to anhydrous ammonia, the proposed plant will produce nitric acid and ammonium nitrate for agricultural fertilizers.

A $16.8 million certificate of necessity has been granted Monsanto to construct new nitrogen facilities, probably near Texas City. However, it is understood that the Monsanto project is part of a long-range plan, and early construction is not anticipated.

Pan American Awards Kellogg Catalytic Reformer Contract

The M. W. Kellogg Company has been authorized to construct a catalytic reforming unit at Pan American Refining Corporation's Texas City, Texas, refinery. The unit is the final step in the present expansion program at the refinery, which includes an expansion of the alkylation unit, a new combination catalytic cracking and polymerization unit, some revisions to present thermal equipment and substantial increases in office, engineering, research and development buildings.

The new catalytic reforming unit will have a capacity of 21,000 barrels a day and will use a process developed jointly by Pan American and Standard Oil Company (Indiana). It is expected that the new catalytic reforming unit will be completed and in operation by fall, 1954.

Great Southern Winding Up Construction of Texas Plant

Great Southern Chemical Corporation's new $5.8 million benzene-toluene-xylene plant at Corpus Christi, Texas, is expected to go into operation early this fall. The plant will derive benzene, toluene and xylene from natural gasoline purchased from several plants in the coastal area. Design calls for a daily intake of 10,000 barrels of raw material. The Platforming and Udex units were designed by Universal Oil Products Corporation and will utilize processes created by U.O.P.

The expansion program by Great Southern involves construction of an entirely new plant with different raw material sources and produce markets from the present butylene plant, which was activated by Great Southern in 1951.

Procon, Inc., is the contractor of engineering and construction of the process units. Construction work was begun in October, 1952, and is now almost completed.

$125,000 Explosion Hits Douglas Bakersfield Refinery

Douglas Oil Company has estimated damage of a recent explosion and fire to its 8500-barrel-a-day Bakersfield, Calif., refinery at $125,000, most of which, the company said, is covered by insurance. No injuries were reported in the explosion, which occured when the lead line from the charge pump sprung a leak.

The topping plant was back on stream last month but the 1500-barrel-a-day cracking unit may be down for a short time, the company said. Pumps suffered heaviest damage, with the pumphouse, process lines and the sides of the casing tower also damaged.

$1.5 Million Expansion Set For Conoco Gasoline Plant

Continental Oil Company's planned expansion program at its Gillis natural gasoline plant near Lake Charles, La., will cost approximately $1.5 million, the company has announced. Contract for the construction, which will start in approximately six weeks, has been let to Hudson Engineering Corporation. Completion is scheduled for early in 1954.

The new facilities will increase the Conoco plant's processing capacity from 27 to 90 Mmcf of gas per day. The output from the new installation will be a mixed stream of propane, butane and natural gasoline. It will be transported to the company's Lake Charles refinery for separation and then marketing. Conoco is presently completing a $29 million expansion program at the Lake Charles refinery, which will increase that plant's processing capacity from 12,000 to 40,000 barrels of crude oil.

WHO'S Building . . .

Standard-Vacuum Schedules Start of Operations at Durban

The 25,000-barrel-a-day refinery of Standard-Vacuum Refining Company of South Africa (Pty.), Ltd., at Wentworth adjoining Durban is scheduled to begin initial operation next January. Substan-

MORE AND MORE PLANT . . .

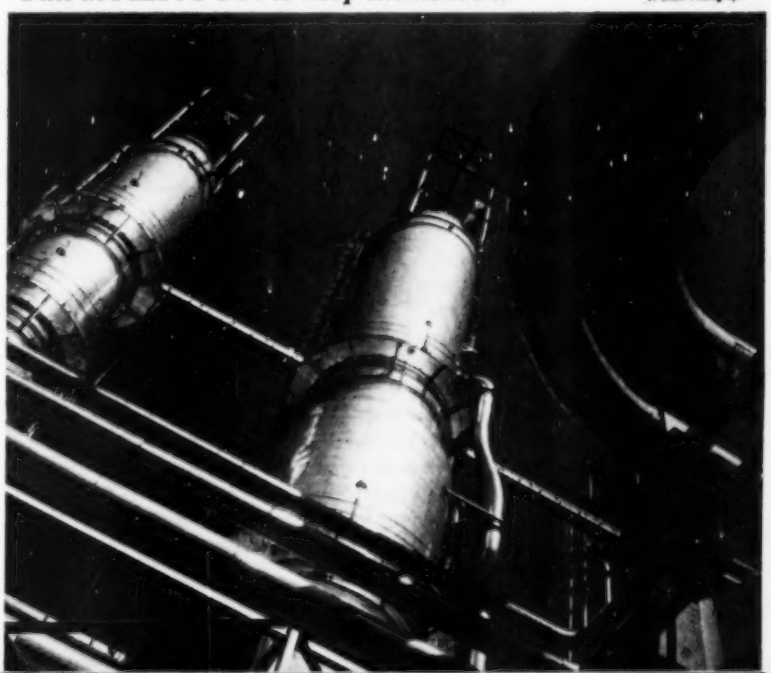
MORE NEED FOR—

Kenyon provide a *complete* thermal insulation service to the oil industry, including technical advice on thermal insulation specifications, and finishes for all conditions. Supply of materials, application, supervision, on sites throughout the world.
The photograph shows columns on the Distillation Unit, M.E.C. project, Shell Haven, England.

KENYON
Planned HEAT INSULATION

Call in KENYON to keep the heat in!

A Shell Photograph



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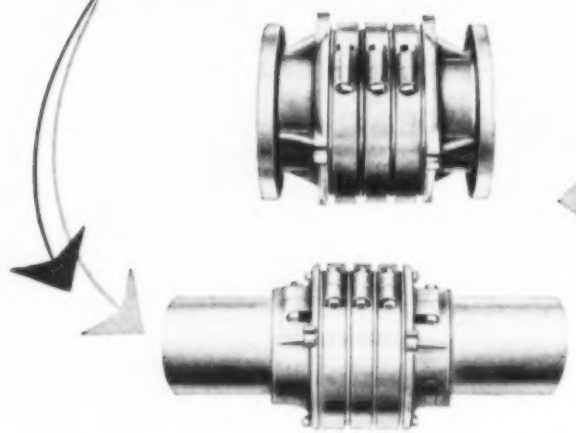
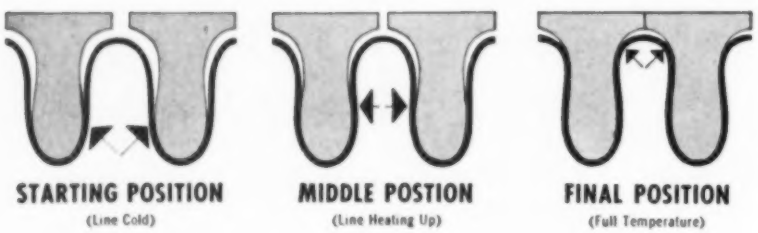
Badger

Directed Flexing

EXPANSION JOINTS





SOME POINTS TO *Check* WHEN BUYING JOINTS

- Does the joint require packing and other maintenance?
- What's the shape of the corrugation?
- What's the shape of the equalizing rings?
- Is there any meaning to these shapes?
- What's the nature of the flexing movement?
- Is this movement well distributed?
- What's the depth of the corrugation?
- What relationship, if any, with the traverse to be absorbed?
- What kind of heat treatment was used in manufacture?

A check on these points, among others, should lead you straight to the Badger Directed-Flexing Self-Equalizing Expansion Joint You can get it in a wide range of standard diameters; in copper or stainless steel ; with flanged or welding ends; in single or double units.

BADGER MANUFACTURING COMPANY

Original and Sole Manufacturer of Badger Expansion Joints

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WHO'S Building . . .

tial progress has been made in the construction under Foster Wheeler Corporation. Standard-Vacuum now has the first group of operating personnel for the new plant undergoing training overseas.

The refinery will be the first in the Union of South Africa, and will be operated by a staff of 300 Europeans.

Sinclair Toluene Unit Heads Latest ODM Write-Off List

Sinclair Refining Company's $14.4 million project to rehabilitate its World War II toluene extraction units at Trainer, Pa., heads the latest list of oil and gas projects approved for rapid tax amortization by the Office of Defense Mobilization. Sinclair will install a 16,000-barrel-a-day catalytic reformer and auxiliary equipment. Of the total cost, $230,000 was certified at 100 percent, $3,920,000 at 50 percent, and the balance at 65 percent.

Other companies receiving fast tax write-off approval, with location, facility, cost approved and percentage certified, were:

International Refineries, Inc.—Carlton County, Minn., 10,000-barrel-a-day combination unit, $5,038,000 at 65 percent; $4,449,900 at 45 percent; and $73,000 at 15 percent.

Caminol Company — Hanford, Calif., catalytic cracking, gas recovery, catalytic polymerization and auxiliary units, $1,494,267 at 45 percent; $148,487 at 45 percent; and $20,000 at 15 percent.

Shell Oil Company—Elk City, Okla., increase natural gasoline liquids production by 95,000 gallons daily, $1,503,000 at 65 percent; $84,000 at 40 percent.

Warren Petroleum Corporation—Greggton, Texas, fractionating facilities to separate 12,000 gallons daily of isobutane, $142,234 at 100 percent.

Phillips Petroleum Company—Alvin, Texas, depropanizer and two 880 hp. compressors at natural gasoline plant, $525,000 at 65 percent.

Sunray Oil Corporation—Duncan, Okla., petroleum refining, $1,357,500 at 65 percent; $50,000 at 40 percent.

Crown Central Petroleum Corporation—Houston, aviation alkylate at $2,493,535 at 100 percent; $564,393 at 50 percent.

Atlantic Licenses Two to Use Catalytic Reforming Process

Two more oil companies have been licensed to use Atlantic Refining Company's catalytic reforming process for petroleum refining. Mid-Continent Petroleum Corporation will operate a 7500-barrel-a-day "catformer" unit at its West Tulsa, Okla., refinery, while Douglas Oil Company of California has been authorized to install a 2500-barrel-a-day unit at Bakersfield, Calif. Atlantic's catalytic reforming process is said to obtain greater amounts of high-quality gasoline from crude oil than other refining methods.

Third Atlantic "Catformer" Put in Operation by Husky Oil

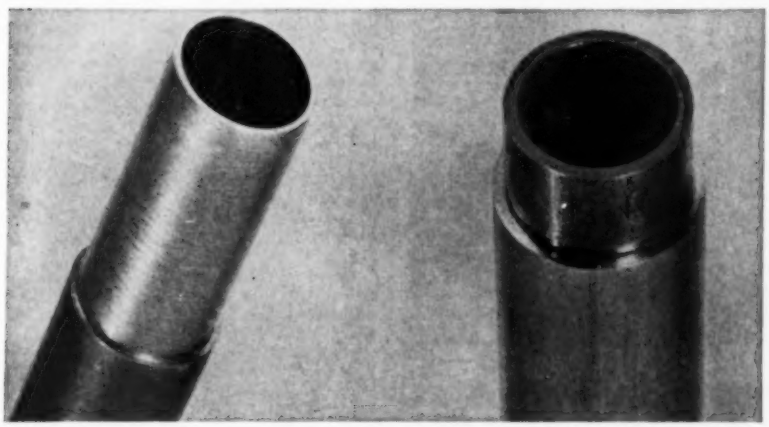
Husky Oil Company has put into operation a new 1000-barrel-a-day "catformer" at its Cody, Wyo., refinery. The unit is the third in a series of installa-

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Duplex Tubes are double walled—composed of two different metals specially designed to fight both inside and outside corrosion. For example, in ammonia refrigeration systems, steel to the ammonia side and copper or a copper-base alloy to the water or brine side increases heat transfer rate and extends service life with reduced maintenance.

Improving Ammonia Refrigeration Systems With Duplex Tubing

Since ammonia and similar nitrogen compounds are finding greater applications in refrigeration, synthetic chemical compounds and as liquid fertilizers, it is important that we learn how to handle these corrosive gases and liquids.

Dry ammonia gas is not corrosive to most metals and alloys. However, when ammonia is mixed with water and air (oxygen), it severely attacks copper and copper-base alloys.

On the other hand, steels are very resistant to ammonia corrosion. This explains their wide use in the construction of equipment and heat exchangers for producing and handling ammonia and its compounds. The presence of salts such as ammonium nitrate increases the corrosivity of ammonia towards iron, aluminum, zinc, and cadmium.

Ammonia Refrigeration

Corrosion from the water or brine side has always plagued operators of ammonia refrigeration systems. Steel tubes have long been used with ammonia and are satisfactory in withstanding corrosion from the ammonia side, but on the water side rust quickly builds up a heat insulating layer which must be removed from time to time at considerable cost. This is now being overcome through the wider use of Duplex tubes composed of low carbon steel to the ammonia side and copper or copper-base alloys, which stand up well, to the water side.

The most popular Duplex tube combinations are low carbon steel outside and copper, Admiralty, or Red Brass inside towards waters from rivers, lakes, ponds, or wells. When sea water is used for cooling purposes, Duplex Tubing with Cupro Nickel, Duronze IV (arsenical aluminum bronze), Aluminum Brass, and Admiralty are popular. Where high water velocities may cause impingement corrosion, the first three mentioned alloys are superior to Admiralty.

Improved Heat Transfer with Lower Maintenance

Mechanical bonding between the two components of Duplex tubes is so tight that very satisfactory heat transfer characteristics result. The designer can use the fouling factor for copper or copper-base alloys rather than the higher value customarily used for steel. Slime, algae, and marine growths have less tendency to foul copper-base alloys than steel. The use of copper or copper alloys on the water side results in continued high heat transfer characteristics compared to single wall steel tubes whose heat transfer value becomes lower as a thicker insulating coat of rust builds up.

For these reasons smaller size heat exchangers, equipped with Duplex tubes, can be designed to have the same total heat transfer as larger size units with steel tubes. Also, when steel tubes are replaced with Duplex (steel/copper), the improved heat transfer rates result in higher operating efficiency.

An ice company that replaced its steel tubes with Duplex (steel/Admiralty) reported two years later that four semi-annual back-breaking cleanings have been avoided; operating pressures are running 15 to 20 pounds lower; and that their new Duplex tubes have already paid for themselves.

A leak at the tube sheet is dangerous, if not soon corrected, as it may permit sufficient ammonia to contaminate the cooling water or brine, accelerating corrosion of the copper or copper-base alloy component of the Duplex Tubing. Corrosion from contaminated water is most severe at the inlet end of the tubes where turbulence is highest.

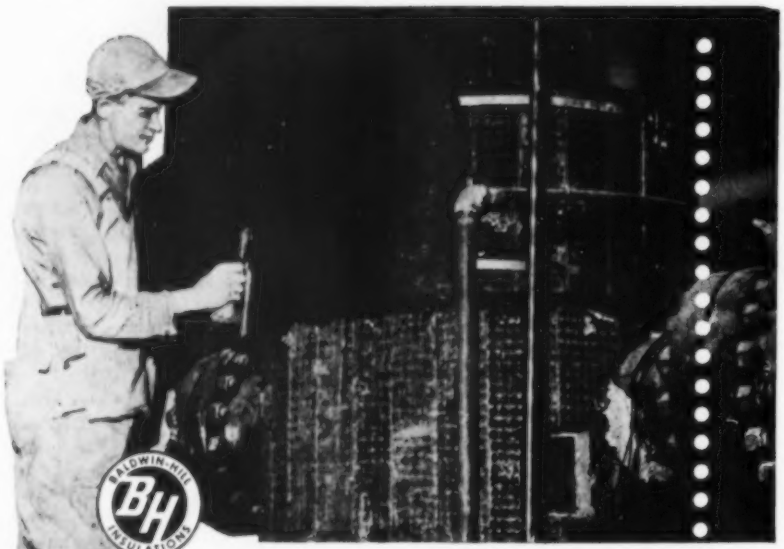
Duplex Has Many Advantages

The use of Duplex tubes has increased greatly during recent years because of the following factors:

1. They do an excellent job where a dual corrosion problem is involved.
2. Reduce maintenance, shutdown time and labor.
3. Conserve metals since corrosion rates are greatly reduced.
4. Resist corrosion from untreated and treated waters better than steels.
5. Improve heat transfer characteristics or higher efficiency as compared with single-wall ferrous alloys.

If you have a corrosion problem that is difficult to handle, consult our Corrosion Laboratory. It is quite possible that there is a Duplex Tubing combination which is the answer to your problem. Write for the "Duplex Tubing Technical Bulletin No. 1950." (359)

BALDWIN-HILL uses PETROLEUM REFINER to help you keep heat losses down with



POWERHOUSE CEMENT

Here are six outstanding advantages:

- ONE COAT COVERAGE . . . It insulates as it finishes. Easy trowelling and quick hydraulic setting save time and labor in application.
- GREATER ECONOMY . . . 100 lb. covers 120 sq. ft. 1/4" thick or 30 sq. ft. 1" thick. Low material cost and single coat application provide low over-all installation cost.
- NO WIRE MESH . . . In many instances can be trowelled directly on blocks, blankets, or other surfaces, thus saving costly application of reinforcement.
- DRIES WITHOUT CRACKING . . . Negligible lineal and volumetric shrinkage provides freedom from drying-shrinkage cracks.
- NO WEATHER WORRIES . . . Applied outside, it withstands drenching rain within two hours of application.
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WHO'S Building . . .

tions of Atlantic Refining Company's catalytic reforming process for petroleum refining. It will produce high-octane gasoline by the new process developed in Atlantic's research laboratories. Atlantic is licensing the "cat-forming" process to a number of other refiners.

PAD Requests Reports on Aviation-Gasoline Facilities

Refiners building new facilities to boost production of aviation gasoline are being asked to submit complete information about the facilities and make regular reports on the progress of construction, Deputy Petroleum Administrator Joseph A. LaFortune has announced.

Reports are to be made on two new PAD forms, which are now being distributed:

Form PAD-79, which provides for a detailed description of any project for construction of alkylation, alkylation-supporting, or other aviation-gasoline facilities.

Form PAD-80, which provides for a report on the stage of construction of each of such facilities on the first of each month until it is completed.

Reports are being requested only from those refineries whose projects would increase the production of alkylate or aviation gasoline by at least 100 barrels a day.

Texas Gas Adds Refrigeration To Winnie Gasoline Plants

A 1500-ton refrigeration unit will be built at Texas Gas Corporation's Winnie, Texas, gasoline plants at a cost of $800,000. The unit will cool the natural gas so that more liquids may be obtained from the gas.

The two gasoline plants at Winnie process approximately 175 Mmcf of gas a day. The water in the area is so warm it cannot cool the gas sufficiently to extract all the liquids, such as propane, butane and natural gasoline.

Gasoline Plant Construction was awarded the contract and work has already started.

Monsanto Subsidiary Starts Production of PVC in Mexico

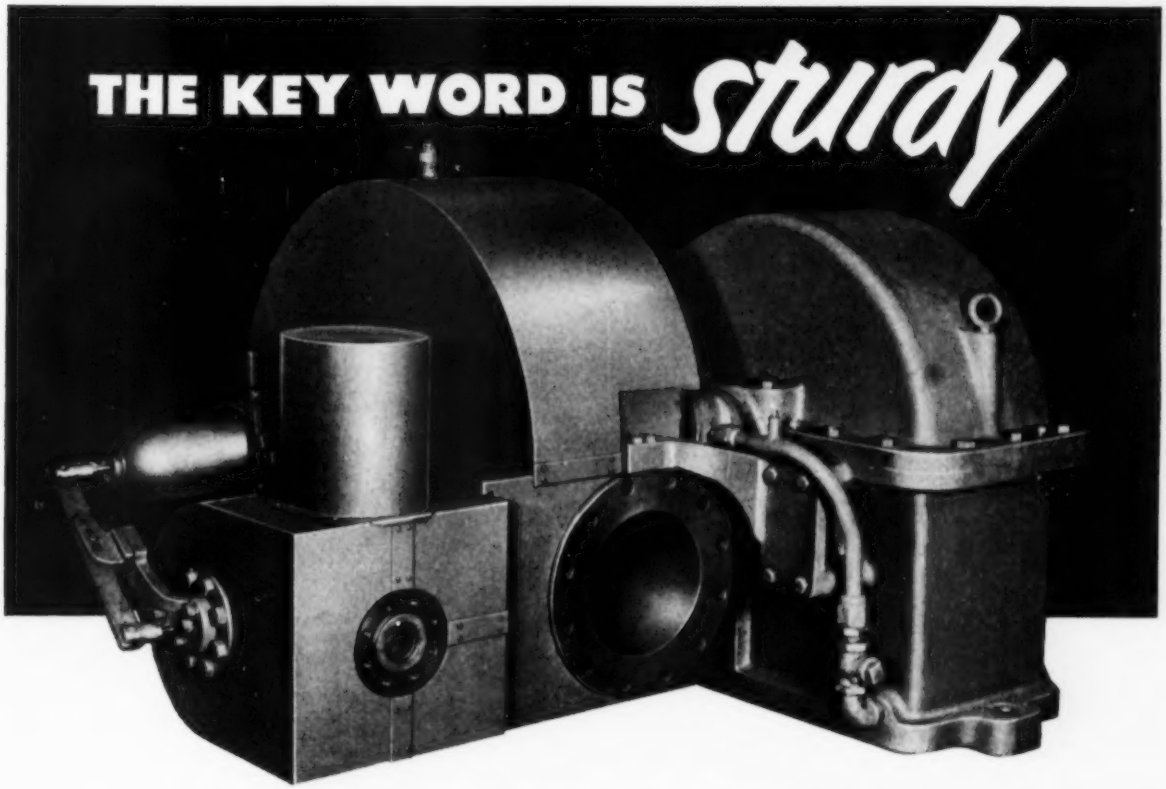
Monsanto Mexicano, S.A., Mexican subsidiary of Monsanto Chemical Company, has started manufacturing polyvinyl chloride resin at its Lecheria plant near Mexico City. At the present time none of the material will be exported since Mexican plastics producers will use the initial capacity. The plant, open since February, 1951, initially produced styrene monomer and then a year later added Fibestos acetate molding compound. The new PVC plant is the first of its kind in Mexico.

Puerto Rican Refinery Will Be Largely Financed in U. S.

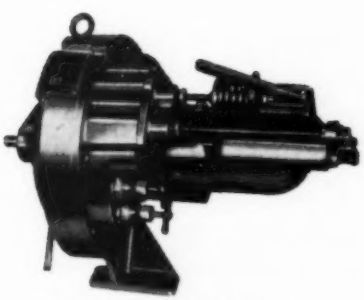
The Caribbean Refining Company has announced that it will construct a 10,000-barrel-a-day oil refinery at San Juan, Puerto Rico. Construction plans for the refinery are complete. To be built by The Fluor Corporation, Ltd., of Los Angeles, it is expected to be in operation by January, 1955.

Principal stockholders of Caribbean

THE KEY WORD IS *sturdy*



THE *new* ELLIOTT GEARED TURBINE



The new JR turbine

At the turbine end, the ever-dependable and popular Elliott YR Turbine, which has demonstrated its remarkable staying powers beyond all question in every industry utilizing auxiliary steam drive units. The versatility of this machine, with its wide selection in governors and controls, is only matched by its strength and "keep-going" endurance.

At the gear end, the equally tough gear assembly with gear and pinion of double-helical type to provide quiet power flow without thrust. Pinion and turbine wheels are both mounted on the same shaft. Jig-drilled bolting in gear-case and turbine insure positive alignment and a rigid unit. Bearings have forced-feed lubrication, and the gear has oil sprays at the meshing point to insure lubrication and cooling.

Also available in "coupled" type, with individual turbine and high-speed gear shafts flexibly coupled.

For details contact your local Elliott representative, or write Elliott Company, Jeannette, Pa. for bulletin.

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STEAM TURBINE DEPARTMENT

H3-2

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WHO'S Building . . .

Refining, a new company, include Pontiac Refining Company, Corpus Christi, Texas; Gulf Oil Company, Pittsburgh; J. H. Whitney & Company, New York; Cosden Petroleum Company, Big Spring, Texas; Emby Kaye, Tulsa, Okla., and H. M. Byllesby & Company, New York. The Government Development Bank of Puerto Rico also is participating.

Argentina Expects New Refinery To Supply 40 Percent of Needs

The new Presidente Peron plant in Argentina, which will go into operation shortly, is expected to cover about 80 percent of the country's requirements from domestic refineries.

According to official government statements in Buenos Aires, the new refinery will make a total capacity in government-owned facilities of about 112,000 barrels a day. An additional 40,000-barrel-a-day capacity is available in privately owned plants, thus giving the country an aggregate capacity of slightly more than 150,000 barrels a day.

The new Presidente Peron refinery, located at Eva Peron (formerly La Plata), is a 28,300-barrel-a-day installation, including fluid catalytic cracking, alkylation and one of the world's largest delayed coking units. It is being constructed by the government Yacimientos Petroliferos Fiscales under the supervision of Kellogg Pan American Corporation.

Australian Shell Completes New 25,000 Barrel Refinery

The 25,000-barrel-a-day refinery of Shell Company of Australia, Ltd., at Geelong has been completed, together with the first section of a 36-mile pipe line to carry products to Melbourne. The refinery will go on stream early next year and will produce 16,000 barrels a day of gasoline, together with other products for Australian markets.

Corpus Christi Refining Lets Refinery Construction Contract

Texas Engineering Construction Company will engineer and construct topping and vacuum units at Corpus Christi Refining Company's Corpus Christi, Texas, refinery. The new units will cost $175,640.

Suntide Refining Refinery To Go on Stream This Month

A new refinery at Corpus Christi, Texas, which will be operated by Suntide Refining Company is scheduled to go on stream this month. Initial crude runs to stills will be in the neighborhood of 30,000 to 35,000 barrels a day.

Hydrodesulfurization Unit To Start Operation in 1954

The hydrodesulfurization unit being built at Shell Oil Company's Stanlow refinery in England is expected to begin operation early in 1954. The newly announced Shell hydrodesulfurization process provides for the catalytic extraction of sulfur from liquid feed stocks in the form of H_2S.

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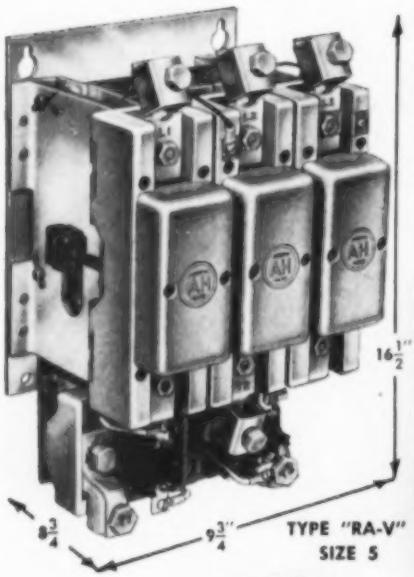

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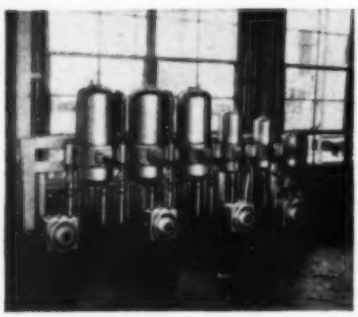

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Meet Our **Authors** . . .

• CONTINUED FROM PAGE 132

Pompeo Has Experience With Control Instruments

D. J. Pompeo, "Electrical Problems in Petrochemical Process Control," page 127.

Born in New Jersey, D. J. Pompeo received his B.S. degree in physics and engineering from the California Institute of Technology, Pasadena, Calif., in 1926. Two years later he joined Shell Development Company to organize the Glass Blowing department. For the past twenty years, he has been engaged in the development of laboratory apparatus and analytical types of quality control instruments for refineries and chemical plants.

Fish Authority Looks At Pollution Problems

Howard P. Clemens and Phillip Summers, "Will Refinery Wastes Kill Fish?" page 145.

For the past two years this assistant professor of Zoology, University of Oklahoma, has acted as pollution consultant for various oil companies and has been engaged in stream pollution studies. And, in addition to that, Dr. Clemens spent three years in "year round" aquatic research on the Great Lakes, two of which were spent at the Franz Theodore Stone Institute of Hydrobiology. He spent the summers of 1950, 1951 and 1952 with the Oklahoma Game and Fish Department, concerned with fish management studies. All of which makes Dr. Clemens well qualified to write the article appearing in this issue.

Born in Arthus, Ontario, Canada, he received successively his B.S. degree from the University of Western Ontario in 1946; his M.S. degree from the University of Western Ontario in 1947; and his Ph.D. degree in limnology from Ohio State University in 1949.

He joined the faculty of the University of Oklahoma in 1949 as an instructor of zoology, advancing to assistant professor in 1951. In his spare time he enjoys photography, birds and scouts.

Phillip Summers is a student of Dr. Clemens at Oklahoma.

Teaching and Industry Divide **Rase's** Time

Howard F. Rase, "Take Another Look at Economic Pipe Sizing," page 141.

This assistant professor of chemical engineering at the University of Texas received his B.S. degree in chemical engineering at the school for which he now teaches. Between graduation from Texas and enrolling at the University of Wisconsin for further study, he spent two years at The Dow Chemical Company as a chemical engineer and almost five years as process and project engineer for Foster Wheeler Corporation.

He returned to school in 1950, receiving his M.S. degree at Wisconsin and in 1952 a Ph.D. degree.

For several summers now, he has returned to industry to work for Foster Wheeler.

the great snark hunt

LOOKING FOR OIL is often like looking for the snark, a creature which has one very odd characteristic: it doesn't exist at all.

For oil is just about the most elusive prey on earth.

In spite of the difficulties of seeking something which very often isn't even there, Cities Service geologists have participated in opening up some of the greatest oil fields in America . . . the Oklahoma City, Eldorado, Kansas and East Texas discoveries, to name a few.

As you read this, Cities Service geologists are tramping over Canadian tundra, wading through Louisiana marshes, climbing mountains, breathing desert dust, seeking—and finding—oil for the rapidly growing needs of your home, factory, farm and automobile.

Because of such men, America's oil reserves are greater now than at any time in our history.

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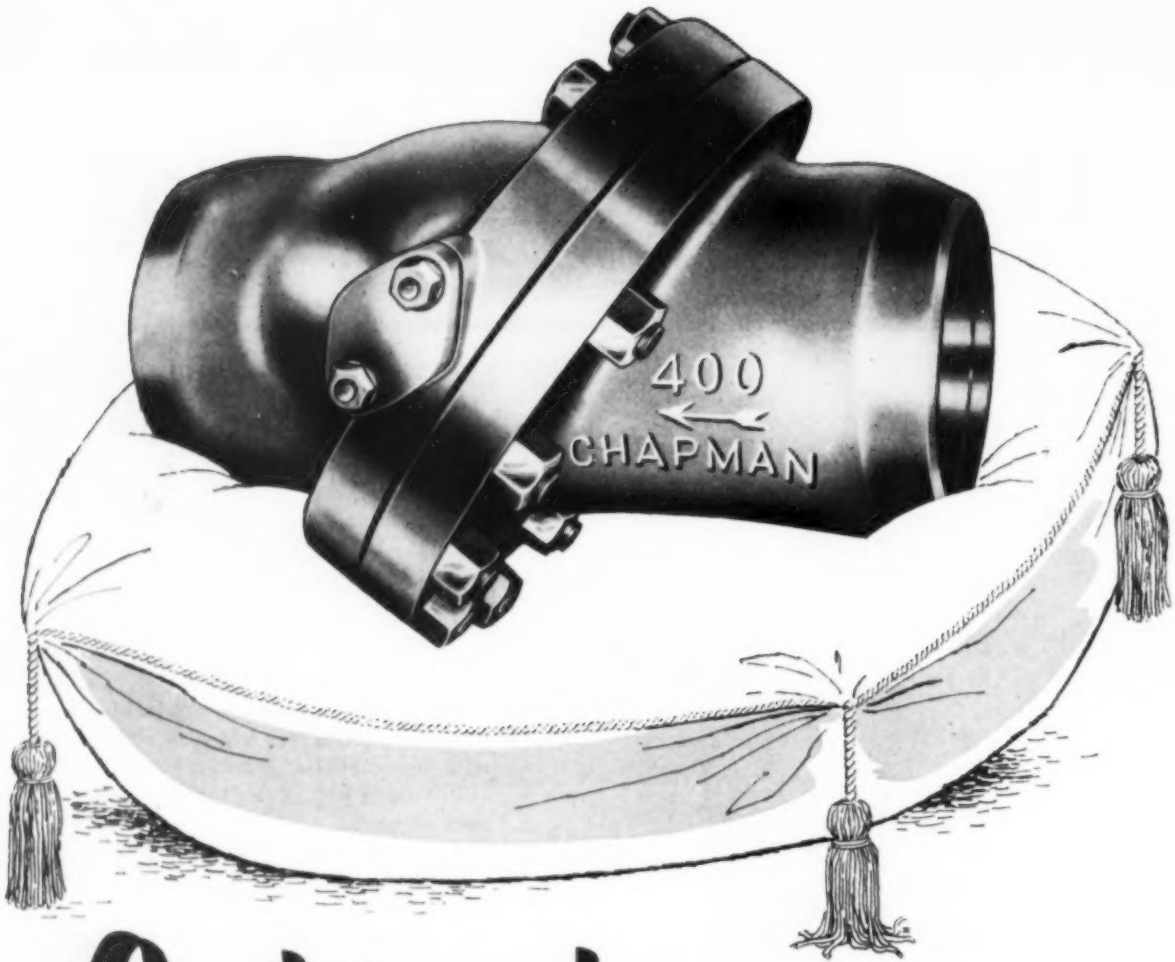

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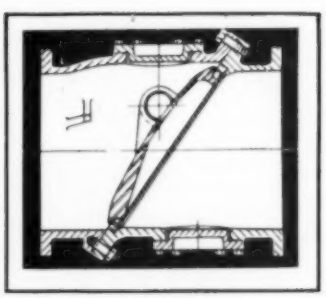

Here's what Chapman means by "Cushioning:"

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CHAPMAN TILTING DISC **CHECK VALVES**

NEW **BOOKS . . .**

Today's Research Program

Review of Current Research and Directory of Member Institutions, Engineering College Research Council, American Society for Engineering Education, 103 Mechanical Engineering, The Pennsylvania State College, State College, Pa. $2.50.

With the U. S. research program expected to reach an all-time high in 1953, any review of current research is a formidable undertaking. The Engineering College Research Council, aware of the enormity of the task, approaches it cautiously and with the sincere hope that its findings may be one small help in the solution of some of the problems of the growing program.

It is believed that in 1953 the nation will spend over $3 billion on research and development. The colleges alone will spend sums approaching $200 million, a large part of which will come from the Military.

The Council hopes, through the publication, to give a picture of all research programs at all of the member colleges. This is difficult because the titles themselves are merely incomplete labels incapable of conveying the entire story. The Council would like to be able to separate vigorous research programs on which a great deal of energy is being expended from those which are carried on as an avocation for the intellectual satisfaction of the research worker. This, to, is difficult to do. By asking for figures on manpower and money, the Council thought to point out the differences between two research projects which may bear the same name but which may be subject to widely different degrees of emphasis, and therefore have widely different probabilities of producing an immediate result.

This current issue should be of interest to those who want to know who else is working in the field, and also to those whose duty it is to review research proposals and those whose duty it is to help students choose research projects by identifying avenues of research which are being vigorously pursued.

All branches of engineering and most related fields research are covered in the 103 institutions which are currently members of ECRE. There are over 13,000 faculty, graduate students and research engineers engaged in the approximately 7500 research projects reported, which have an expenditure of approximately $65 million annually.

Catalytic Activities

Cracking Catalyst Activity in the Presence of Hydrogen Sulfide, Institute of Gas Technology, 17 West 34th Street, Technology Center, Chicago 16.

Catalytic Cracking of natural gas and other hydrocarbons of low molecular weight has achieved industrial importance as a method for producing utility gases and petrochemical raw materials. Emergency conditions, economic factors and depletion of hydrocarbon sources may necessitate charging sulfur-contaminated stocks not now useable because of loss of catalyst activity due to sulfur poisoning.

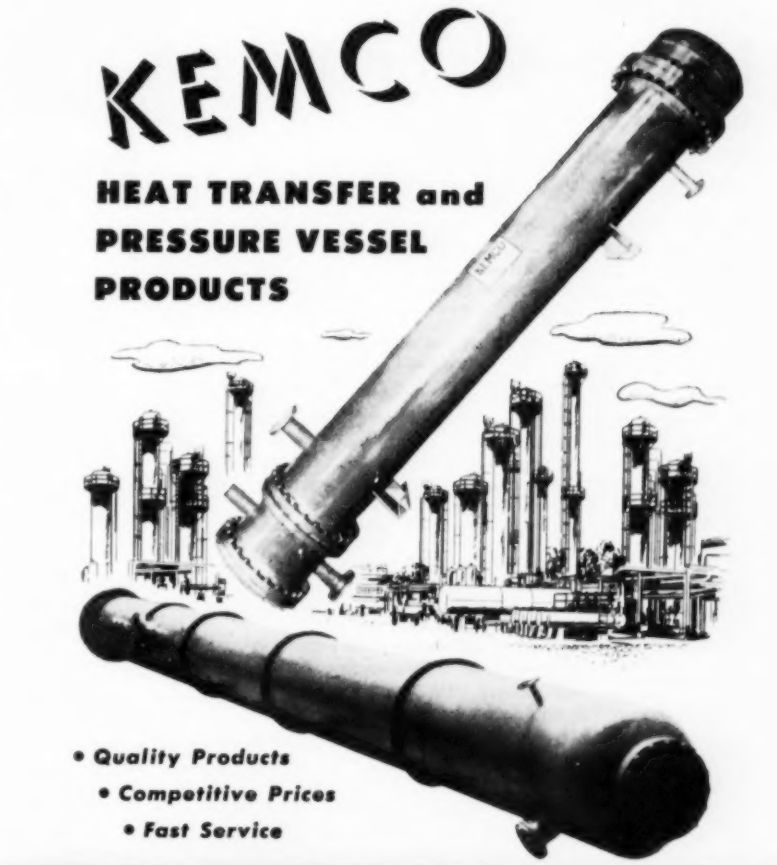
Results of a study of catalytic activities of various elements are presented in this IGT Research Bulletin No. 4. The search for a highly active, sulfur resistant catalyst was conducted by the Institute of Gas Technology under the sponsorship of the American Gas Association.

Elements known to have activity in the steam-hydrocarbon and related reactions were tested in oxide, sulfide, and reduced forms. They were nickel, iron and cobalt of Group VIII, chromcolumbium and tantalum of Subgroup Va, with thoria and zirconia of Subgroup IVa as promoters. Their activities in the absence of sulfur were first determined; hydrogen sulfide was then added to the feed stream and their activities were noted at half-hour intervals for the three hours of each test.

Measurement and Sampling

ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products, American Society for Testing Materials, 1916 Race Street, Philadelphia 3. $1.50.

Prepared by a special division of ASTM Committee D-2, the second edition of this manual presents practical measurment practices that are widely used today. Actually, it comprises seven ASTM Standards, but with considerable additional explanatory and descriptive material. The book provides recognized methods of measuring and computing oil in storage tanks of various types and for getting typical samples. All except one of the methods are presented in revised form.



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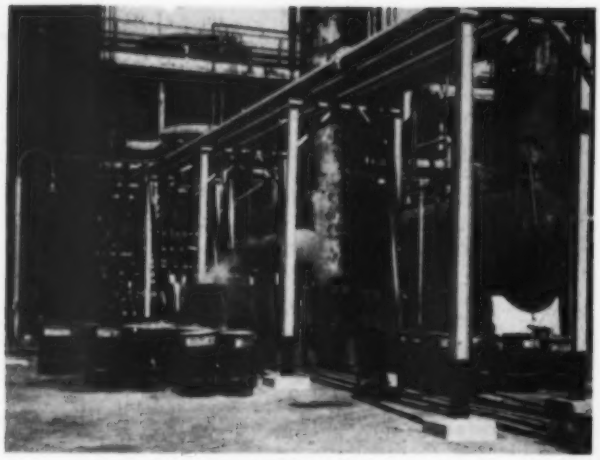

Turnaround time shortened one day by new cleaning method

Comparative report shows Oakite tower cleaning also cuts overall cleaning time 20%— saves on materials, too.

THIS well known refinery was not satisfied with the time it took to chemically clean equipment for Gas Recovery turnaround. To compare jobs and costs, Engineering decided to test two different methods—one of which used Oakite Compound No. 88.

The Oakite Technical Service Man was called in to help on procedure and contribute his specialized knowledge on refinery cleaning problems.

The refinery engineers' report on Oakite No. 88 speaks for itself. "... no gas disposal problem ... no chance of running tower over ... no static head to leak ... no delay ... cheaper from chemical consumption standpoint." Most important were these conclusions: "Oakite procedure should cut overall cleaning time by 20%... Recovery turnaround would be at least one day shorter."

Proving that—
in industrial cleaning it always pays to consult Oakite.

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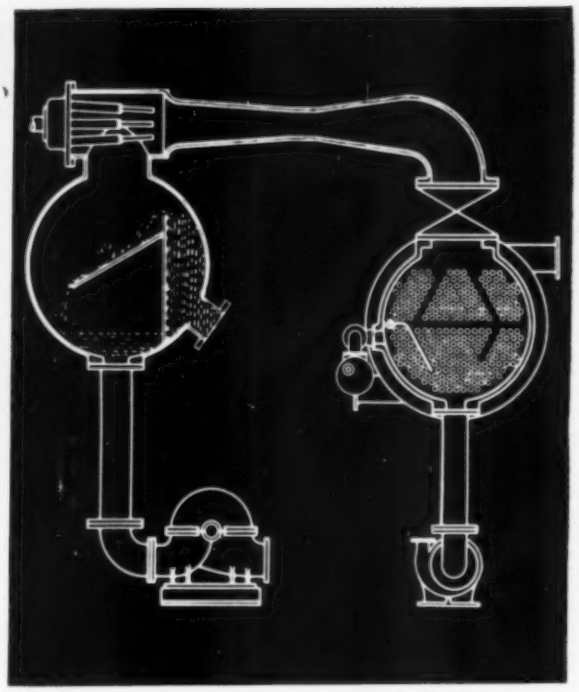

Water cools itself with a C-R Chill-Vactor

A Chill-Vactor is a three-stage steam-jet vacuum unit which serves to flash-cool water and certain other liquids through temperatures down to 32° F. No chemical refrigerant is used. There are no moving parts. Water literally "cools itself" by partial evaporation at high vacuum. Vacuum refrigeration is usually less expensive than mechanical refrigeration in first cost as well as operating cost.

Chill-Vactors are producing chilled water in industrial plants throughout the world. They are cooling chemical solutions, fruit juices, milk, whiskey mash, etc. Bread and other baked goods have been vacuum cooled successfully for years. Other products, such as lettuce, spinach, celery and other leafy vegetables, are being cooled to temperatures around 33° F. in quantities up to 200 cars a day.

The Chill-Vactor is only one type of steam-jet Evactor manufactured by Croll-Reynolds. Let our technical staff help you with any or all of *your* vacuum problems.

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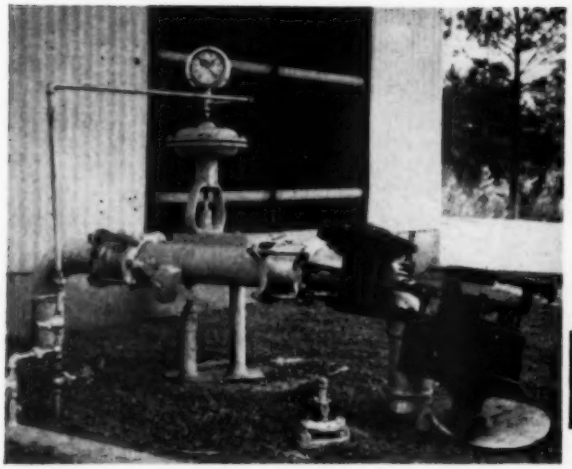
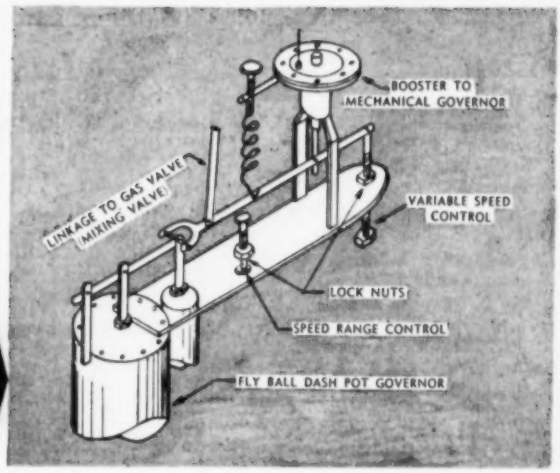
How to **DO** It...



Pressure Control System . . .



. . . features spring mechanism.

Butterfly Regulates Compressor Speed

Discarded equipment plus originality yields this very practical solution to a difficult problem.

The field superintendent and maintenance foreman of the Arkansas Fuel Oil Company's Dorcheat-Macedonia vacuum compressor stations were having trouble holding atmospheric pressure on the suction of the engines without some mechanical control. The problem was caused by high fluctuations in the gas load. It was found that by pinching a suction valve and installing a governor booster, the trouble was partially eliminated. However, there was still some fluctuation in the static pressure on a minimum and maximum load.

On a maximum load, the pressure would rise and do no damage, but on a minimum load, the pressure would be lowered below atmospheric, and, if there were any leaks in the field, air would enter and cause excessive corrosion in pipe lines. This was due to the fact that in Southwest Arkansas, the wells are dually completed, with the Cotton Valley and Smackover lime formation separated by a mechanical packer. This packer at times will let minute particles of hydrogen sulfide from the Smackover lime formation enter into the Cotton Valley formation, which is the gas that these compressor stations are handling.

Some thought was given to placing a regulator in the line to hold a constant pressure on the field, but the high cost of a regulator installation was too great. The maintenance and field men got their heads together and installed a diaphragm regulator head on a fulcrum to control, by field pressure, the mechanical governor above its set speed. The top of this diaphragm was connected to the up-stream side of the meter run. The control was adjusted to remain at a closed position and have no control over the depression of the fly ball governor until the pressure on the inlet of the meter run exceeded three pounds.

This was done by a spring as shown in the sketch. The spring is a fuel injector spring.

Then a bypass was made around the valve on the suction of the engine and in this a diaphragm operated butterfly was installed. On the side of the butterfly an arm with a weight was attached, so that by moving the weight, it would increase or decrease the pressure required to operate the diaphragm which, in turn, operated the butterfly.

In a cut and try method, it was found that the best operation, because of the rapid change in gas load was to set the mechanical flyball governor to control the engine at a minimum speed with a minimum load, and the butterfly to operate as close to zero gage pressure as possible. As the butterfly opened up (due to the increase in field pressure) to a wide open position, the increase in pressure across the meter run and separator would exert approximately three pounds on the governor booster, thereby increasing the engine to its maximum speed.

After the load of gas had been decreased to where the pressure on the governor booster no longer acted on the flyball mechanical governor arm, the engine would come back to its minimum speed.

This diaphragm-operated governor booster and butterfly has a wide variety of uses, particularly where there are quite a few engines and one may go down anytime. This mechanism can be set to operate the suction pressure to the rest of the engines, and the increased field pressure made to increase the speed of the engines running and to keep the rest of the engines from being overloaded. The accompanying photograph gives a good idea how the butterfly operates and also how the governor booster is attached to the mechanical flyball governor.

This item was a prize winning "Operation Kink" presented by T. O. Hamaker, Magnolia, Ark., at the Tyler, Texas, NGAA Meeting, October, 1952.

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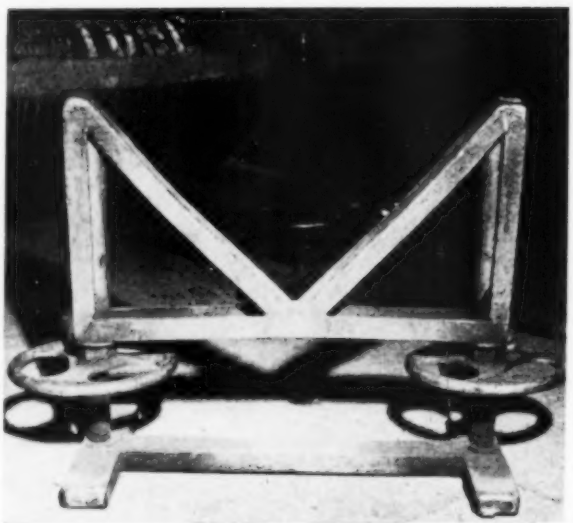
How to **DO It** . . .

V-Block **Simplifies Pipe Fabrication**

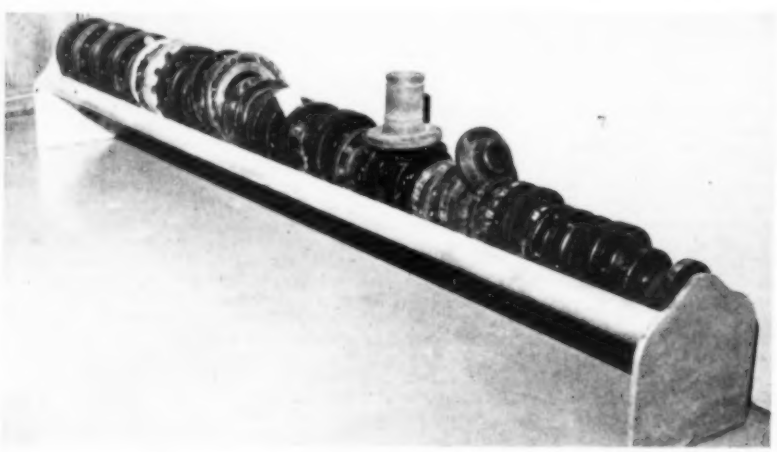


An adjustable V-block that speeds and simplifies pipe fabrication can be made easily in almost any mechanical shop. The V framework is made of heavy section two-inch channel iron and braced with one-inch pipe. This pipe also forms a housing for the threaded section of the screw-jack made from alloy stud bolts and hex nuts. The bolts are one inch size.

The base of the device is of solid one-inch steel plate welded in an "H" shape. The two stud bolts are welded in an upright position to the base.

The handwheels are of five-eighths-inch steel rod welded to a hub of one-fourth-inch plate. The two hex nuts are centered inside the wheel. Note the two bearing plates made of oversized steel washers.

In the process of fabricating pipe, the handwheels permit minute adjustments of the pipe, and enables the fabricator to increase his accuracy. The total travel of the V-jack is nine inches.



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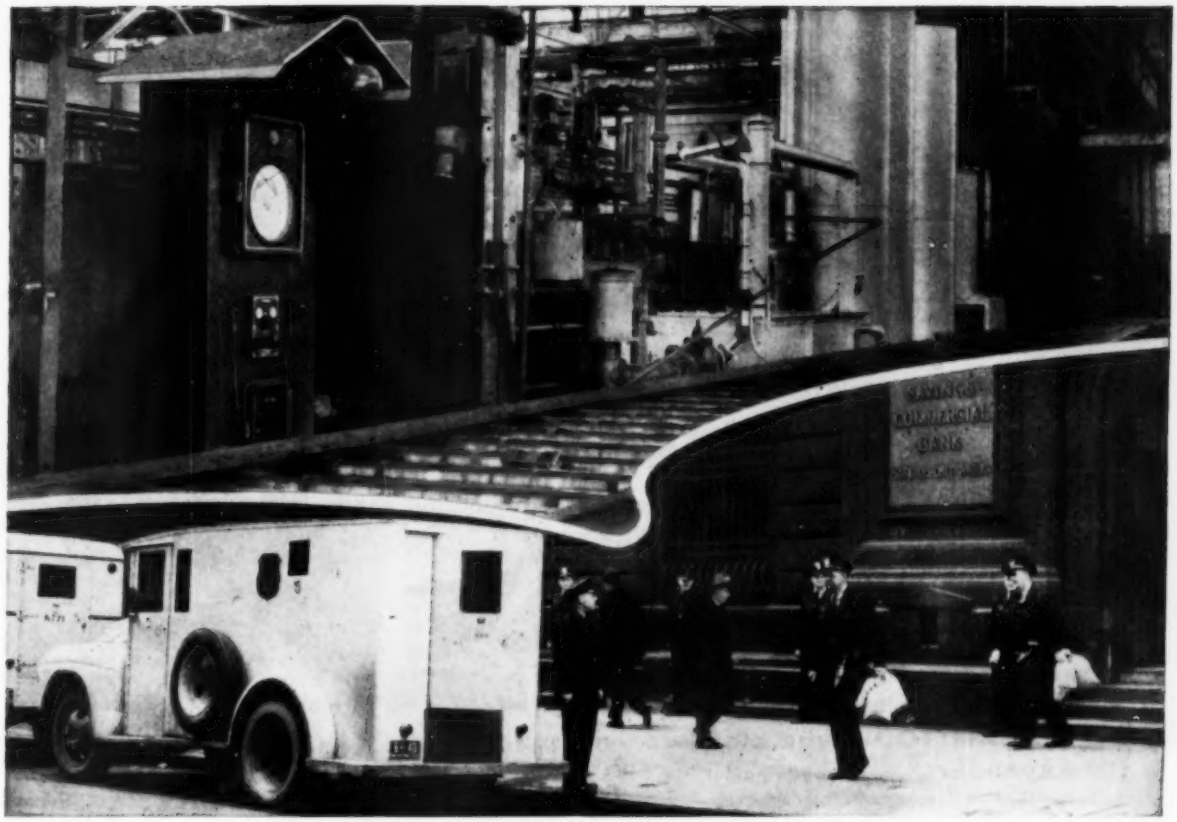
Why stack flanges on top of one another or hang them on the wall when you can store them in a rack like this one that is easy to make? Ordinarily flanges pose a difficult problem around a warehouse. More often than not they end up on the floor or in bins. This simple rack can hold all of the flanges ordinarily stocked.

Weld two lengths of 3-inch pipe to end plates cut from ¾-inch plate. Space the two pieces of pipe closer together at one end than at the other, in order to accommodate various sizes.



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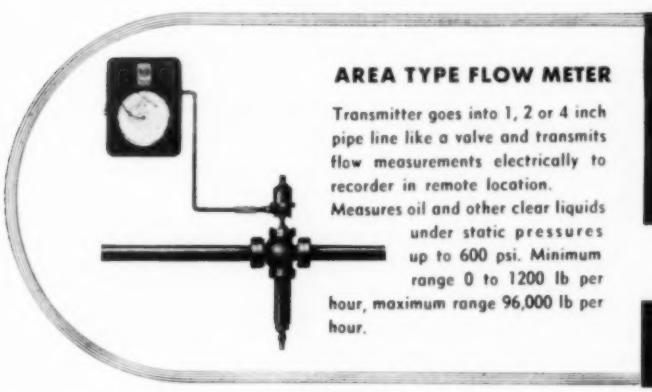
Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



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Make a stand for pipe thread compound which can be moved about the rig in easy reach of the drilling crew.

Weld 3-inch diameter base plates on 1½-inch pipe legs of desired height. Attach legs to a base made of thin steel strips which have been shaped to the contour of the bucket and have been attached to a supporting ring 12 inches in diameter. Handles can be welded to the structure to facilitate moving. When the lubricant bucket is set into this structure, it will remain upright, eliminating hazards of contamination.

Other variations of the stand can be made. One type illustrated is the table stand. Weld a table with 6-inch steel sides and mount it at the corners with legs made of 1½-inch pipe.

It's Time to Cash In

Make money . . . share ideas with others . . . in Petroleum Refiner's How to Do It contest . . . You have ideas, we want them . . . $10 for each one accepted . . . Best in '53 gets $100, second, $50, and third, $25 . . . Send ideas with sketches or photos to Editor, Petroleum Refiner, P. O. Box 2608, Houston, Texas . . . Do it now!

Who's Meeting . . .

NACE

The Western Region of the National Association of Corrosion Engineers will hold its 1953 Fall Conference November 19-20 at the Biltmore Hotel in Los Angeles. Featured will be meetings of Technical Practices Subcommittee No. 1A on corrosion of oil and gas well equipment (Pacific Coast), Technical Practices Sub-committee No. 6L on asphalt type underground protective coatings, and two technical sessions, one on refinery corrosion problems and the other on aircraft corrosion problems. The two technical sessions will be half-day affairs. The conference will start the day following termination of the University of California at Los Angeles Corrosion Short Course, November 16-18.

Another Corrosion Short Course in the NACE program will be held at Texas A & M, September 22-25, with experienced corrosion engineers serving as teachers. This course will be given by the South Central Region of NACE in cooperation with Texas A & M's chemical engineering department. Subjects to be covered include: fundamentals, materials of construction, coatings, cathodic protection, instrumentation and special topics. Small group discussion sessions will be featured. Registration fee is $25.

NACE *Annual*

The Tenth Annual Conference and Exhibition of the National Association of Corrosion Engineers has arranged nine symposia for the conference to be held at Kansas City, March 15-19, 1954. According to F. L. Whitney, chairman of the Technical Program Committee, titles of two round table sessions and three other symposia are under consideration.

Whitney also said sessions will be held on pipe line coatings and pipe line corrosion problems in much the same manner as those successfully held at the 1953 NACE meeting at Chicago last March. Educational lectures on the fundamental aspects of corrosion also will be given.

Symposia scheduled definitely, where assigned and names of symposium officials follow:

Cathodic Protection Symposium—

Chemical Industry Symposium—E. G. Holzberg, Alloy Steel Products Company, Linden, N. J., chairman.

Corrosion Principles Symposium—H. P. Godard, Aluminum Laboratories, Ltd., Kingston, Ontario, chairman.

Power and Communication Industry Symposium—R. M. Lawall, American Telephone and Telegraph Company, Cleveland, chairman.

Elevated Temperature Corrosion Symposium—G. A. Fritzlen, Haynes Stellite Division, Union Carbide & Carbon Corp., Kokomo, Ind., chairman; E. N. Skinner, The International Nickel Company, Inc., New York City, co-chairman.

Oil and Gas Production Symposium—R. C. Buchan, Humble Oil & Refining Company, Houston, chairman.

Protective Coatings Symposium—N. K. Senatoroff, Southern Counties Gas Company, Los Angeles, chairman.

Pipe Line Coatings Symposium—A. D. Simpson, Jr., United Gas Corporation, Houston, chairman.

Refinery Industry Symposium—E. H. Tandy, Standard Oil Company of California, El Segundo, chairman.

Round table discussions slated:

Pipe Line and Underground Corrosion.

General Corrosion Problems—L. E.

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Who's **Meeting**

Stout, Washington University, St. Louis, chairman.

Other symposia being considered are Non-Destructive Testing, Corrosion by Atmospheric Pollutants and Cost of Corrosion.

Educational lectures will be under supervision of R. C. Weast, Cast Institute of Technology, Cleveland, chairman.

ISA

The Fifth Preconference ISA Maintenance Clinic has been scheduled for the three days prior to the opening of the Eighth National Instrument Conference and Exhibit in Chicago. Running September 18-20, the clinic program will include these subjects: pyrometers, millivoltmeter type; electric instruments; mechanical and electrical potentiometers; electronic potentiometers; graphic panel instruments; control valve selection and maintenance; combustion control; oxygen recorder; flow meters—electrical type; liquid level control and control valves; area type flow meters (rotameter), and self-operated controls.

Classes in the Morrison Hotel will begin Friday, September 18, at 1 p.m. A total of nine two-hour sessions will be held, three each day. Friday evening will be devoted to a general session on "Principles of Instrumentation and Automatic Controls."

The clinic is open to ISA members and members of ASME, AIEE and IRE without charge. Non-members will pay $3 registration. Registration, which will close September 14, should be with the national office of ISA, 1319 Allegheny Avenue, Pittsburgh 33.

AIChE

The New York Section of the American Institute of Chemical Engineers will hold a symposium October 22, on "Management," "New Materials of Construction," and "Solids Handling." The all-day meeting in two sections, will be held at Hotel New Yorker, New York.

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IN THE FUTURE

SEPT. 6–11	American Chemical Society (124th National Meeting), Conrad Hilton Hotel, Chicago.
13–16	American Institute of Chemical Engineers, Fairmont and Mark Hopkins Hotels, San Francisco.
15–16	American Petroleum Institute (Executive Committee), Greenbrier Hotel, White Sulphur Springs, W. Va.
16–18	National Petroleum Association (51st Annual Meeting), The Traymore, Atlantic City.
21–25	Instrument Society of America (8th National Instrument Conference and Exhibit), Sherman and Morrison Hotels, Chicago.
24–25	Western Petroleum Refiners Association (Regional Meeting), Henning Hotel, Casper, Wyo.
27–30	American Society of Mechanical Engineers, Petroleum Division (Annual Petroleum Mechanical Engineers Conference), Rice Hotel, Houston.
27 to Oct. 2	American Society for Testing Materials (Committee D-2), Shoreham Hotel, Washington, D.C.
OCT. 8– 9	California Natural Gasoline Association (28th Annual Fall Meeting), Ambassador Hotel, Los Angeles.
11–17	Oil Progress Week.
19–23	National Safety Council (Annual Congress), Conrad Hilton, Congress, Morrison, Sheraton, Chicago.
22–23	Western Petroleum Refiners Association (Regional Meeting), Garrett Hotel, El Dorado, Ark.
23	Natural Gasoline Association of America (Regional Meeting), Blackstone Hotel, Tyler, Texas.
NOV. 2– 4	American Oil Chemists' Society (27th Fall Meeting), Sherman Hotel, Chicago.
2– 6	American Institute of Electrical Engineers (Fall General Meeting), Muehlebach Hotel, Kansas City, Mo.
9–12	American Petroleum Institute (33rd Annual Meeting), Conrad Hilton Hotel and Palmer House, Chicago.
19–20	Third Annual Instrument Short Course, Los Angeles Harbor Junior College, Wilmington, Calif.
21	Natural Gasoline Association of America (Regional Meeting), Herring Hotel, Amarillo, Texas.
29 to Dec. 4	American Society of Mechanical Engineers (Annual Meeting), Statler Hotel, New York.
DEC. 13–16	American Institute of Chemical Engineers (Annual Meeting), Jefferson Hotel, St. Louis.

As to Oil's **Outlook:**

• CONTINUED FROM PAGE 93

ports grows the availability of imports will drop sharply. Because of world shortage either the U. S. or other countries will have to do without full measure of natural petroleum. We may continue to have fiscal advantage, but political advantage may lie elsewhere.

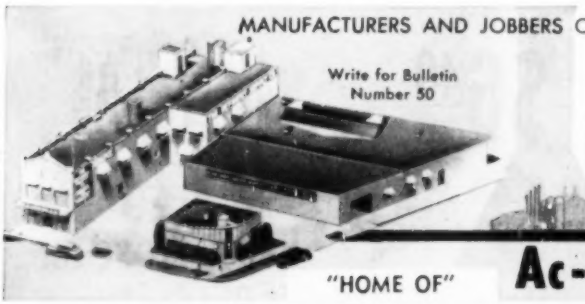
At first glance, the picture of the future as drawn may seem rather dismal for the U. S. It is true that some other countries may have a moderate cost advantage over the U. S. for a decade or two, because supplemental liquid fuels will cost more than natural petroleum. But it happens that the U. S. is blessed with exceptional abundance of oil shale and coal. Eventually the whole world must depend upon supplemental fuel sources, and about half the oil shale and coal of the world is in the U. S. If we feel that we must do any worrying about the future we should concentrate our attention on the few decades of transition (starting before 1970) when we shall have less natural petroleum while the rest of the world has more. Between 1970 and the end of the century we shall have to devote more attention to efficient use of liquid fuel in its unique applications and to efficient manufacture of liquid fuel from oil shale and coal.

As late as 1950 it was predicted that the largest advance in future sale of liquid fuel would be for uses competitive with solid fuel—for example, burning under steam boilers. This now seems quite contrary to the trend of fuel technology. It is also contrary to statistics since 1950. Except for ship bunkers, residual fuel oil should gradually disappear as a fuel and should be converted, instead, into distillate fuels such as gasoline and oils for diesel and jet engines. Economics will take care of this. Liquid fuels will cost too much to be used in competition with solid fuels or natural gas. We shall look back on present fuel practices with mild amazement. Fortunately we know now how to convert residual fuel oil to premium products. The technological stage is set and the curtain will rise as soon as process economics permits. This should come well before any substantial amount of coal conversion and, when widely practiced, should cut down a little on demand for natural petroleum.

The next development will be oil from oil shale. This, like conversion of residual fuel oil, is now on the verge of profitability. A small rise in the cost of crude petroleum will be enough to bring commercial operations to Colorado, but it seems doubtful that production of shale oil will ever provide a substantial part of our liquid fuel. Moderate rate of production will be at relatively moderate cost but high rate of production may be uneconomic.

The last and most permanent stage of liquid fuel development will be, of course, the conversion of coal. This will give the most expensive but the most abundant liquid fuel if total conversion is carried out either by the Fischer-Tropsch process or by hydrogenation. But such processes are wasteful of fuel resources. If liquid fuels are made as by-products of electric power generation through low-temperature carbonization of coal and consumption of char as boiler fuel, the combined operation should be less wasteful of BTU's and should yield lower-cost liquid fuel. The volume of liquid fuel that could be provided would depend on the relative markets for liquid fuel and electric power, and on the proportion of liquid fuel demand to be supplied in this way.

If all of present electric power (ex-



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cept that provided from hydro plants) were to come from the combustion of low temperature char, we would obtain as a by-product only a few percent of present consumption of liquid fuel. But at present this would be more than enough, and demand for electric power is rising more rapidly than demand for liquid fuel. Thus the proportion of our liquid fuel requirements that could be provided in this manner should become steadily greater as time goes on. Extrapolation of present trends indicates that rising potential production of by-product liquid fuel might be nearly enough to balance supply with demand.

Distillate Fuel Picture

In Figure 4 is indicated the way in which our supply of *distillate* fuels may be provided over the next two decades. Such a break-up is a risky thing to attempt and may look quite absurd later on—for it assumes so many circumstances that can be only guessed at today. But planning for industry must involve some sort of future picture—even if it is faulty. As years pass by the faults will "cast their shadows before." The picture can be continually revised and, if necessary, redrawn, but Figure 4 may provide a suitable starting point.

For total supply of distillate fuel it is assumed that demand will be 80 percent of predicated demand for crude petroleum. For shale oil it is assumed that production will start before 1960 and will grow slowly to about 0.3 billion barrels per annum in 1970. For coal conversion it is assumed that operations will start soon after 1960 and will grow rapidly to 1.7 billion barrels per annum in 1970. For domestic production it is assumed that conversion of residual fuel will be under way before 1960 and will be virtually complete by 1970. This bends the curve toward horizontal. It is assumed that imports of petroleum will continue to increase to a maximum of 1.3 billion barrels after 1960 but will have decreased by 1970 to around 0.8 billion barrels. If we can produce more petroleum and import more, our dependence on coal will be less and the time-table for coal conversion will be delayed. Higher fuel costs may tend to slow down the rise of fuel demand. These are only a few of the many things that may go wrong with Figure 4.

So far little has been said about costs. Here is one interesting thing: In a static economy petroleum requires a minimum of capital outlay and operating cost compared with supplemental liquid fuels. To maintain constant production we need only maintain a constant proved reserve. But in an expanding economy it is necessary to "prove up" about twelve barrels of additional reserve for every barrel of *increased* production. The reason for this is that rate of production must be only about a twelfth of proved reserve. In the U. S. it has been necessary for proved reserves to increase at a far greater rate than production. This is sometimes mistakenly cited as a reason for optimism, but it is also an explanation for the high cost of petroleum discovery. The element of petroleum cost that is increasing most rapidly is discovery, and this is being magnified by expansion of demand.

Estimated costs for distillate fuels from oil shale are only a little higher than average costs from petroleum. Before 1960 the costs may be equal. Distillate fuels from coal would now cost two or three times as much as from petroleum but the relationship should be altered rapidly after 1960 not only because petroleum costs will be rising but because coal conversion technology will be improving.

I have tried to portray the future in definite terms. In so doing I have pointed out some of the obvious elements of uncertainty. As time goes on these elements will be gradually resolved.

Catalytic Chemistry

By HENRY W. LOHSE

Consulting Chemist, Fellow of the Royal Society of Arts, London; Canadian Institute of Chemistry; American Chemical Society; American Assn. for Advancement of Science.

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Chapter III. Nature and Properties of Catalysts
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Chapter V. Industrial Catalytic Reactions

This book aims at a factual presentation of the underlying principles of catalytic phenomena and the application of catalytic reactions in industrial processes.

Particular attention has been paid to the presence of impurities in catalytic reaction systems, and to the role of traces of other metals in silver, copper, iron, nickel, etc., used as catalysts.

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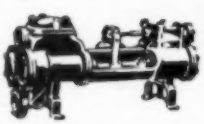

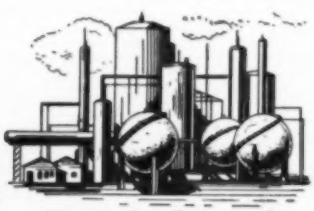

Repair Cost for Valves in Sludge Burner Pump

Valve parts were being replaced monthly in a large Eastern refinery. When Sims Pump Valves were installed — *guaranteed* to give longer service — *no* maintenance was necessary for over a year. Service then indicated a change in spring materials — cost: $6.40 — and an even further reduction of repairs was gained.

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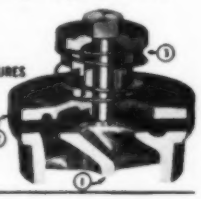

What **Suppliers** Are Doing . . .

Rheem II Gets Promotion to Rheem Assistant General Manager

Rheem Manufacturing Company has promoted W. S. Rheem II from Western division manager to assistant general

Rheem

Bergen

manager for the entire company. The promotion came following the company's acquisition of a new plant in Seattle and two fiber drum firms in California.

Rheem, who started with the company 15 years ago, will supervise all manufacturing and marketing activities in the Southern division as well as on the West Coast. He will also assist C. V. Coons, vice president and general manager, in administration of all the company's 12 U. S. plants. He was made Western division manager last year.

Succeeding him as Western division manager is E. C. Bergen, who has been regional manager of the Rheem plants in Richmond, Calif., area. Bergen joined Rheem in 1937 in engineering and maintenance.

U. S. Steel Division Announces Two Gulf Coast Area Changes

In appointments announced by the Oil Well Supply Division of United States Steel Corporation, Harry A. Rowe has been made store manager at Beaumont, Texas, and James T. Love has been appointed district engineer, refinery and pipe line sales, for the Beaumont, Orange and Port Arthur, Texas, area.

Prior to his appointment, Rowe was assistant to the district merchandise manager at "Oilwell's" Houston warehouse. He began work for the division in June, 1943.

Love managed the Beaumont store before being appointed. He began work with "Oilwell" in March, 1946, and was appointed head of the Beaumont store in 1950.

Allied Chemical & Dye Division Makes Three Department Changes

Three appointments have been announced by the Engineering department of Solvay Process Division, Allied Chemical & Dye Corporation.

I. H. Munro, who has been chief engineer nearly two years, takes over the post of assistant to Carlton Bates, Solvay's executive vice president. Munro, who joined Solvay's Engineering department in 1935, was appointed chief engineer in December, 1951.

As a result of Munro's new assignment, Raymond Largent has been promoted to chief engineer, and William E. Dugan, Jr., to assistant chief engineer. Largent has been a Solvay employe since 1937, Dugan since 1946.

Sales Promotion Manager Named In Promotions at Ohio Injector

Two staff promotions have been made by Ohio Injector Company to implement the increased work of sales managers and salesmen in the field resulting from recent company growth.

Harry C. Bell, veteran in the valve industry, will become manager, engineering sales, representing sales managers in decisions on new product design. Paul E. Warner, formerly sales manager of Ohio Injector's Atlantic division, has been named manager, sales promotion. P. J. Gallagher, formerly sales manager of the Lubricated Plug Valve of the H. K. Porter Company, which was recently purchased by Ohio Injector, will replace Warner.

General American Assigns Seery To Replace Duffy at Pittsburgh

Frank E. Seery, Pittsburgh assistant district sales manager of the Plate and Welding division, General American Transportation Corporation, has been appointed district sales manager of the division. He replaces Ben King Duffy, who has resigned to enter business for himself.

Seery has been with General American for seven years. He will be assisted in his new assignment by J. A. Ross, Jr., who has been located in the company's Washington, D. C., office for six years.

American Meter Adds Space—

At the recent formal opening of American Meter Company's displacement meter plant at Nebraska City, Nebr., William G. Hamilton, Jr., president of American Meter, cut the ribbon as part of the opening day ceremonies. Looking on were Nebraska City Mayor Bremmer, left, and Arthur F. Benson, vice president-engineering.

The new plant adds 48,000 square feet of space for displacement meter production to American Meter's ten U. S. plants.

New Instruments Service Shop Opened in Vancouver by Foxboro

A completed equipped shop for servicing and repair of The Foxboro Company's instruments has been opened in

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Worthington Holds 100th Year Sales Conference—

In recognition of its 100th year in export trade, Worthington Corporation recently held an International Sales Conference at which managing directors and executives of the company's overseas operations were taken on a tour of the firm's Buffalo Works. Shown above are four members of the conference looking at ammonia refrigeration compressors during the tour. From the left, Horace Wood, assistant general manager, Export department, Worthington; J. J. Thompson, manager, personnel department, Worthington; G. J. Andriessen and E. Blanchart, distributors of Worthington refrigeration equipment in the Netherlands and Belgium, respectively.

Vancouver, B. C. Announcement of the opening was made by The Foxboro Company, Ltd. of Montreal, Canadian affiliate of Foxboro.

The new facilities were made necessary by the increased use of Foxboro instruments in the industrial expansion of the western provinces, the company said.

Donald Rutledge, who has many years experience in instrument production, is in charge of the new shop.

Rockwell President Named to "Outstanding Young Men" List

Willard F. Rockwell, president of Rockwell Manufacturing Company, has been selected one of Pittsburgh's "100 Outstanding Young Men." He is 39.

The 100 were chosen on the basis of accomplishments to date in their respective fields as well as their civic contributions and "future promise." Rockwell was one of the 25 representing industry.

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Here is a rugged hand-tool that "works around corners" for removing old packing from stuffing boxes. The picture shows how a pair of these flexible handled tools operate around obstructions for snagging out those old packing rings. All steel—tempered tool steel corscrew bit.

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M-H Enlarges Field Sales Force With Addition of 22 Engineers

Twenty-two sales engineers have been added to the field sales force of Minneapolis-Honeywell Regulator Company's Industrial division in 19 branch offices located in 17 U. S. and 2 Canadian cities. The additions are the second announced this year. Last February, 25 sales engineering graduates were appointed to field posts.

The new appointees, all graduates from the company's industrial instrument training school in Philadelphia, include: Carl C. Crawford, New York; William R. Bisbee, Wichita, Kan.; Russell W. Cornell and Frank P. Mark, Montreal; Albert E. Finn, Boston; John P. Gille, Tulsa; Robert M. Goble, Dallas; Charles A. Heyelman, Buffalo; Henry N. Jelinek and William G. Nash, Cleveland; John F. Johnson, Chicago, and Jennings K. Lagerstrom, Kansas City, Mo.

Also, David J. McDonald, South Bend, Ind.; Paul L. Meyers, Indianapolis; Billy F. Schaible, Denver; Howard P. Smith, Jr., Pittsburgh; Patrick J. Suddick, Toronto; Brian F. Trankle and Harold E. Musgrove, Los Angeles; Robert L. Woods, Milwaukee; Ellery L. Hall, Seattle, and Charles W. Gunthorpe, New Orleans.

At the same time, 24 service engineers were also added to the firm's field force, taking assignments in branch offices throughout the U. S.

Davison Chemical Corporation Elects Bachman Vice President

Dr. Paul W. Bachman has been elected vice president of The Davison Chemical Corporation. Formerly director of research and development at Davison, he will continue in charge of these activities.

Bachman

Joining Davison in 1949 as manager of development planning, Dr. Bachman was active in technical aspects of the current Davison plant expansion program, including the planning of the sodium silicate and catalyst plant at Lake Charles, La., opened this year, and the triple superphosphate plant now being built at Bartow, Fla.

Pyrofax Gas Names Frost and Ackley to Top Sales Positions

F. W. Frost has been appointed manager and J. A. Ackley, sales manager, of Pyrofax Gas Company, a division of Union Carbide and Carbon Corporation.

Frost joined the company in 1931 as a sales correspondent, later becoming advertising manager and assistant sales manager. In January, 1950, he was appointed sales manager.

Ackley joined Pyrofax in 1937 as credit and sales correspondent, serving successively as field service engineer, field representative for Iowa and southern Minnesota, and district manager for Maryland, Delaware and northern Virginia. He was appointed assistant sales manager in January, 1950.

BS&B Appoints Darr and Unsell To Divisional Sales Positions

Appointment of two district sales managers has been announced by the Oilfield Sales division, Black, Sivalls & Bryson, Inc. Earl Darr is the new Shreveport, La., district sales manager, and Dee Unsell fills a similar post at Denver.

Unsell

Darr

Darr has been with BS&B for the past 18 years, serving as a sales engineer. In his new capacity, he has supervision of sales and service activities of the Oilfield division in the Shreveport sales district.

Unsell has been with BS&B for the past 13 years, serving successively as salesman and city sales manager at Denver. In his new post he has supervision of sales and service activities of the Oilfield division in the Denver sales district.

Warner Lewis Company Promotes Thomas Bradley to Sales Manager

Promotion of Thomas R. Bradley to sales manager has been announced by Warner Lewis Company, fabricators and distributors of water separators, filters and associated products for the petroleum industry.

Bradley

The new sales manager joined Warner Lewis Company January, 1952, as sales promotion and advertising manager. Prior to his association with Warner Lewis he was plant manager of Sunray Gas Company's wholesale bottled gas plant at Washington, Iowa.

Pickering Governor Acquired by Farris Engineering Corporation

Farris Engineering Corporation, Palisades Park, N. J., has acquired Pickering Governor Company, including all patents, inventory and equipment. Production of the governor will be carried on without interruption in the newly enlarged Farris plant.

With this change, the firm becomes a Farris affiliate and will be known as Farris Pickering Governor Company.

20 New Field Engineers Assigned To District Offices by Beckman

Beckman Instruments, Inc., has assigned 20 new field engineers to district offices throughout the U. S. and Can-

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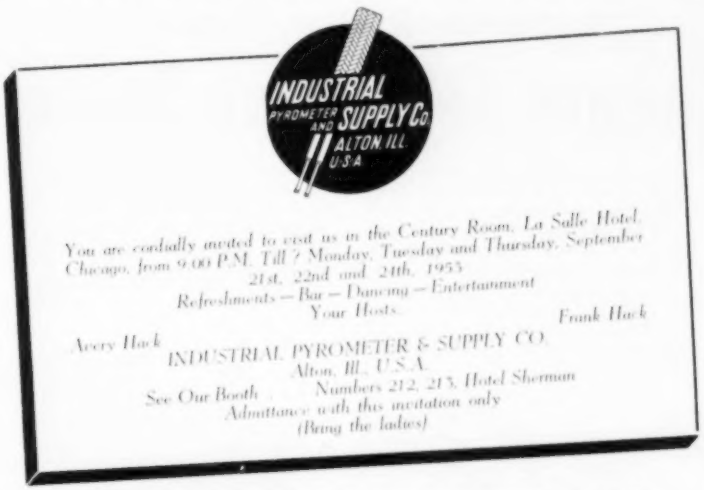
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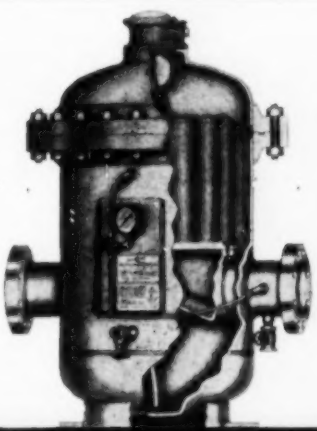

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Nicholson W. O. traps also have many applications in natural gas industry: drain gasoline from scrubber head of booster and gas lift compressors; gasoline, oil or moisture from gas well separators, accumulators, after-absorbers, etc.; packaged natural gasoline plants; gas lines.

4 TYPES—press. to 200, 500, 650, 1500 lbs.; for every large capacity, heavy-duty use.

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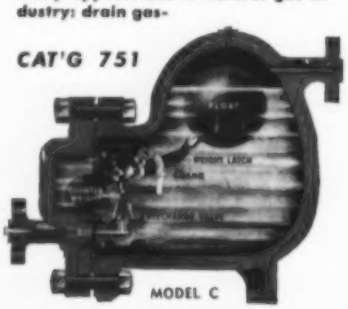

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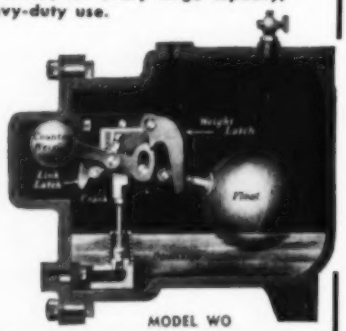

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Bagenstose and Miller Made Insul-Mastic Regional Managers

The Insul-Mastic Corporation of America has promoted Abner H. Bagenstose to Eastern regional manager and placed

Miller

Bagenstose

John J. Miller in charge of the Midwestern territory. The two men will work from the company's Pittsburgh home office. As company representatives, they will give technical and sales assistance to the contracting firms in principal cities which are licensed to sell and apply Insul-Mastic's line of protective coatings.

Bagenstose has been with the Insul-Mastic sales staff for five years, Miller was formerly an Insul-Mastic service engineer.

Cooper-Bessemer Appoints Smith New Engineering Representative

Appointment of Todd W. Smith to its Seattle office has been announced by The Cooper-Bessemer Corporation. The assignment as sales and engineering representative will be under the direction of C. R. Jones, branch manager of Cooper-Bessemer's office and warehouse facilities in Seattle.

Smith

Smith has been associated with Cooper-Bessemer at its engineering and manufacturing plant at Mount Vernon, Ohio. Prior to joining the Cooper-Bessemer organization he was an engineer with Ford Motor Company. His new activities will be devoted principally to the engineering application of heavy internal combustion engines, as well as compressors and pumps.

Worthington's Borchardt Retires

Albert H. Borchardt, vice president of Worthington Corporation, has retired from the company after 44 years of service. Since his appointment as vice president in July, 1951, he has assumed over-all responsibility for the sale of the corporation's entire line of pumping equipment, including centrifugal, reciprocating and vertical turbine pumps.

Shell Development Names Licensee

The Pfaudler Company has been appointed fabricating licensee for turbogrid trays used in fractionating towers under an agreement with Shell Development Company, Emeryville, Calif.

As a result of the agreement with Shell, Pfaudler now will be able to service customers with all three major types of trays used in distillation columns.

Anne Elected Elliott Executive; Crisman Assigned to Pittsburgh

Election of John W. Anne as a vice president and appointment of S. W. Crisman as assistant district manager

Crisman

Anne

of its Pittsburgh office have been announced by Elliott Company.

Anne has been with the company since 1925. Following an apprentice course, he was assigned to the Condenser department. In 1948 he was appointed sales manager of the Jeannette division.

Soon after he joined Elliott in 1935, Crisman was assigned as a field engineer in the Pittsburgh office. He rejoined the Pittsburgh office following his return from service in World War II.

Nalcat Gets West Coast Manager

William E. Conroy, formerly general purchasing agent for Wilshire Oil Company, Los Angeles, has been appointed West Coast manager of National Aluminate Corporation's Catalyst division.

Tracerlab Names District Manager And Three Sales Representatives

William F. Butler has been named Washington District manager in appointments announced by Tracerlab, Inc. Butler has been sales manager of the Philadelphia Sales division of American Optical Company for the past 15 years.

Other appointments included: L. Keith Elrod as southeastern sales representative; William A. McCarthy as Cleveland sales representative; and John H. Klinger as Los Angeles sales representative.

Elrod was formerly a field engineer for the Techrep division, Philco Corporation; McCarthy was formerly field engineer for Tracerlab's Chicago sales division; and Klinger has been a chemical engineer at the Western division laboratory of Tracerlab in Berkeley, Calif.

Concurrent with the appointments, Tracerlab announced the opening of branch sales offices in Atlanta, Ga., and Cleveland.

Keppler Joins American Cyanamid As Technical Representative

American Cyanamid Company has announced the addition of Richard G. Keppler to its Refinery Chemicals department as a technical representative in its New York offices. He will coordinate certain phases of commercial development programs of products.

Before joining Cyanamid, Keppler held important posts with Borne Scrymser Company, Ultra Penn Refining Company and The Standard Oil Development Company.

Mason-Neilan Names Thackara District Manager at Los Angeles

Alex M. Thackara has been appointed Los Angeles district manager of Mason-Neilan Regulator Company. He will head up the sales engineering activities of the company and will also be in charge of the service and repair facilities located in the company's new headquarters at 2822 East Olympic Boulevard.

Thackara

Thackara has been with Mason-Neilan since 1939, except for three and a half years in the U. S. Navy during World War II. He graduated from Massachusetts Institute of Technology in 1939.

Witco Chemical Promotes Brubaker

Promotion of Harry M. Brubaker from assistant sales manager to sales manager of the Carbon Black division has been announced by Witco Chemical Company. Brubaker, with Witco approximately two years, has been associated with the carbon black industry for a number of years. He will continue to be located at Witco's Akron office.

Mine Safety Elects George Deike

Election of George H. Deike, Jr., as a vice president has been announced by Mine Safety Appliances Company. Since 1951 he has been director of engineering and secretary of the company. He has been with Mine Safety since 1931, when

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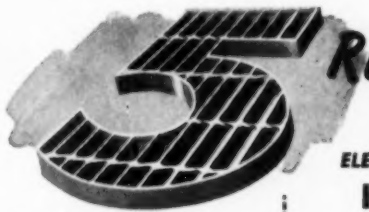

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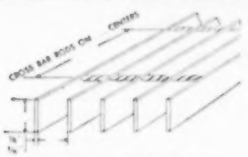

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he joined the company's engineering department.

Deike is also director and treasurer of Mine Safety Appliances Company of Canada, Limited; assistant to the president of Catalyst Research Corporation of America, and holds executive positions in several other concerns.

National Carbon Superintendent Gets Alfred P. Sloan Fellowship

Carl A. Odening, superintendent of the Columbia, Tenn., plant of National Carbon Company, a division of Union Carbide and Carbon Corporation, has been awarded an Alfred P. Sloan Fellowship under the Executive Development Program at Massachusetts Institute of Technology.

Odening

The Sloan Fellowships, awarded on the basis of a national competition among young executives, provide an intensive year's training in industrial management studies. For the past two years, Odening has been in charge of the Columbia plant during its multi-million dollar expansion for increased production of "National" carbon and "Acheson" graphite electrodes. He joined the General Engineering department of National Carbon Company at Cleveland in 1937. Subsequently he worked in the company's Cleveland Research Laboratories, and in the Development Laboratories at Niagara Falls.

G.E. Establishes New Department And Announces Key Appointments

Establishment of a Direct-Current Motor and Generator department has been announced by General Electric Company. Oscar L. Dun, new general manager of the new department, will be located in Erie, Pa. The new department will assume all duties and responsibilities of the company's former D-C Motor and Generator Planning Study. In addition, the department will have the responsibility for the d-c and synchronous motor and generator lines which are now manufactured by the company's Large Motor and Generator department, and the armored motor line produced at Erie.

Appointed to key positions in the new organization were: Paul D. Ross, manager of marketing, Richard M. Hartigan, manager of employe relations, Paul S. Stough, manager of engineering, Louis E. Wengert, manager of finance, and Francis J. Boucher, manager of manufacturing.

Eight men were named to key industry sales posts in the Apparatus Sales division.

They are: O. B. Falls, Jr., manager of electric utility sales; T. F. Mackey, manager of heavy industries sales; K. R. Ross, manager of medium industries sales; W. V. Gough, manager of light industries sales; H. R. Wallrath, manager of contractor and construction industries sales; A. H. Hemker, manager of farm, trade, and services industries sales; H. D. Beale, manager of industry products maintenance; and F. W. McChesney, manager of industry sales procedures.

Magoon Named to Follow Hirshman In U. S. Steel Division Position

C. E. Magoon has been appointed treasurer, National Tube Division of United States Steel Corporation. He succeeds H. J. Hirshman, who is retiring after 49 years service with National Tube, 30 years of which he has been treasurer. Hirshman will remain with the division in a consulting capacity.

Magoon

Magoon was employed by Firestone Tire and Rubber Company from 1924 until he joined U. S. Steel as an auditor in the Pittsburgh general offices of the former Carnegie Illinois Steel Corporation in 1939. In 1944 he was named treasurer of Tubular Alloy Steel, and when that company merged with the National Tube Division that same year, he was named assistant treasurer, a position he held at the time of his new appointment.

Tipton Succeeds Spoerl as Division General Sales Manager

United States Rubber Company has appointed Warren A. Tipton general sales manager of its Mechanical Goods division. Tipton succeeds Walter F. Spoerl, who retires after 45 years of service.

Tipton joined U. S. Rubber as a salesman in Houston in 1935. His most recent appointment was as sales manager of the Mechanical Goods division in 1952.

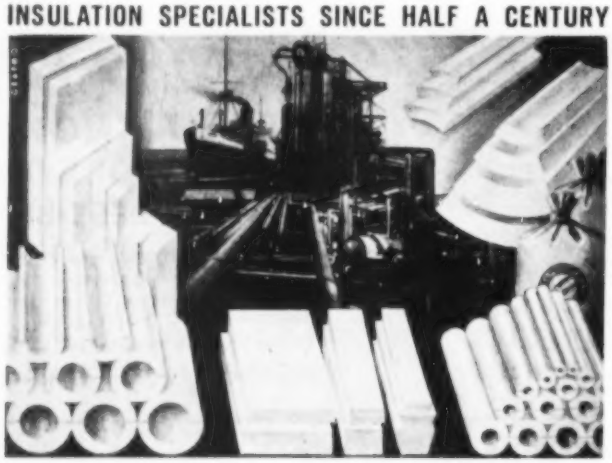
Spoerl started his rubber career in 1908 as a clerk in the company's Chicago sales office. He advanced through several sales and administrative posts, and in 1944 was named merchandise manager. Two years later he became general sales manager for the division.

Chain Belt Appoints Konrad

Appointment of W. N. Konrad as product supervisor for its line of Rex sanitation equipment has been announced by Chain Belt Company of Milwaukee.

Konrad joined Chain Belt in 1948 as a student engineer and, prior to his most recent appointment, worked as a sales engineer in the Sanitation division.

INSULATION SPECIALISTS SINCE HALF A CENTURY



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Carbide and Carbon Appoints McClure to New Executive Post

Harry B. McClure has been named executive vice president of Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. He has been vice president of the company since 1944.

McClure

McClure became a member of the Carbide organization in 1928 as a research fellow at Mellon Institute of Industrial Research in Pittsburgh. He later became a technical representative in the Philadelphia area, transferring to sales work in New York in 1931.

For the past 20 years he has been concerned mainly with the development of new chemicals and finding new industrial uses for these materials. In 1950 he received the first honor award of the Commercial Chemical Development Association for valuable service to the chemical industry.

Canco Names Odiorne Manager

Raymond J. Odiorne has been named manager of American Can Company's new can-making plant at Lemoyne, Pa. He had been assistant manager of the company's Maryland factory at Baltimore for the past two years. The new plant is scheduled to begin operations this year.

Republic Will Build New Plant For Production of Iron Powder

A new patented process for the production of powdered iron has been developed by Republic Steel Corporation, which will utilize the process for the commercial production of iron powder in a new plant to be built soon in Toledo, Ohio. The plant will have a capacity of 50,000 pounds a day.

Republic will build the iron powder plant on land recently acquired near the Toledo refinery of Sun Oil Company. Construction is expected to be completed in the summer of 1954.

Welding Veteran Gets Position With Gregory Industries Division

A. G. Bissell, head civilian of the Welding, Casting and Forging branch of the U. S. Navy's Bureau of Ships for 17 years prior to his recent retirement, has been named engineering consultant to the Nelson Stud Welding division of Gregory Industries, Inc.

Responsible for much of the pioneering work in arc welding, Bissell has been honored several times for his contributions.

Honeck Gets New Graver Post

Graver Water Conditioning Company has appointed A. H. Honeck district manager in Cleveland and Cincinnati. He will maintain an office in both cities and will be available to engineers in his district for solving water treatment problems. He has worked in various departments at the Graver main office in New York as a design, estimating and sales engineer since 1951.

Chief Engineer at Edward Valves Assigned Duties of Works Manager

Edward Valves, Inc., has assigned David MacGregor, chief engineer, the additional duties of works manager of the company. He will now supervise all manufacturing operations and industrial relations, while continuing as chief engineer, principally in an advisory capacity.

MacGregor

MacGregor joined Edward Valves in 1925 as a draftsman. He was successively promoted to designer, chief draftsman and chief designer, advancing to chief engineer in 1943. A native of Scotland, he received his early engineering training at The Royal Glasgow Technical Engineering College, Glasgow, Scotland.

B&W Moves Loughin to New York

Paul R. Loughin, recently named an executive assistant of The Babcock & Wilcox Company, has been transferred to the staff of the company's Boiler division. Prior to his latest promotion, he had been chief of staff engineering for B&W. He joined the company in 1926 as an apprentice engineer. He was made chief of staff engineering in 1947.

Dravo Official Dies

Lucian F. Adams, auditor for Dravo Corporation, Pittsburgh, and its subsidi-

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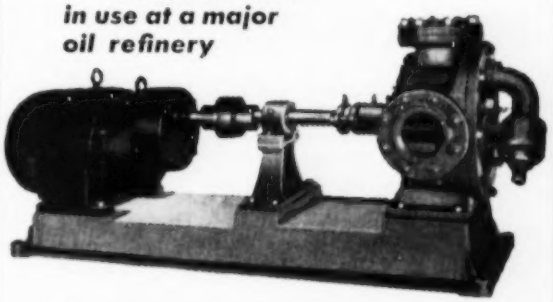

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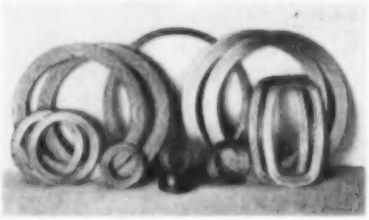

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See Page 254 in Refinery Catalog

ary, Fulton-Portsmouth Bridge Company, Portsmouth, Ohio, died recently after a short illness. He was 58. He had been associated with Dravo Corporation since 1927.

Diamond Alkali Division Names Production and Engineering Head

Promotion of Henry S. Curtis to manager of production and engineering of the Diamond Alkali Organic Chemicals Division, Inc., has been announced by Diamond Alkali Company. His background in the chemical industry includes nine years in various operating and engineering capacities at Westvaco Chemical division of Food Machinery and Chemical Corporation.

Curtis joined the Diamond organization in January, 1951, when he was named assistant general superintendent at the government-owned magnesium plant operated in Plainesville, Ohio, by Diamond Magnesium Company, a subsidiary of Diamond Alkali.

Babcock & Wilcox Stockholders Hike Number of Directorships

Stockholders of The Babcock & Wilcox Company voted at their recent annual meeting to increase the number of directorships from 8 to 11. They elected Edward L. Cochrane, J. H. King and Luke E. Sawyer to fill the newly created posts. Present directors who were re-elected at the same meeting were A. G. Pratt, E. G. Bailey, Alfred Iddles, Paul D. Merica, C. W. Middleton, Stoddard M. Stevens, B. A. Tompkins and John C. Traphagen.

Nixon Elected to Succeed Higgins As Chairman of Hercules Board

Charles A. Higgins has resigned as chairman of the board of Hercules Powder Company. Anson B. Nixon, a vice president of the chemical company since 1940, was elected by members of the board to succeed Higgins.

Nixon

Higgins, who had been chairman of the board since 1944, also resigned as a member of the company's finance committee, but remained a member of the company's board of directors. Albert E. Forster, president of Hercules, was elected to fill the vacancy left by Higgins' resignation from the finance committee.

Forster was elected president only recently when Higgins resigned the post he had held since 1939.

Nixon had served as vice chairman of the board of directors since last year. He became a member of the board in 1932.

Insul-Mastic Licenses Knudsen

Knudsen Company of Syracuse, N. Y., has been licensed by The Insul-Mastic Corporation of America to sell and apply Insul-Mastic protective coatings. Knudsen specializes in insulation engineering. Much of its use of Insul-Mastic coatings will be in the vaporsealing of insulation.

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Snodgrass, Willes and Gettig Get New Assignments at Rockwell

Reassignment and promotion of three plant managers has been announced by Rockwell Manufacturing Company in preparation for the planned opening of the firm's Sulphur Springs, Texas, plant late this year.

Floyd V. Snodgrass, former general

Gettig

Snodgrass

Willes

manager of the Nordstrom Valve division plant at Oakland, Calif., has been appointed to supervise production and operations at Oakland and Sulphur Springs.

Replacing him as general manager at Oakland is W. D. Willes, general manager of the company's Barberton, Ohio, plant since September, 1952. W. T. Gettig, former works manager of Edward Valves, Inc., a Rockwell subsidiary, has been named general manager at Barberton.

Snodgrass joined the company as a machinist in the Oakland plant in 1935, served as plant manager and assistant general manager before being named general manager in 1949.

Willes joined the Nordstrom Valve division in 1944 as an industrial engineer in charge of methods and standards. In 1947, he was made production manager at Oakland and in 1949 was promoted to works manager.

Gettig joined Edward Valves as a machine operator in 1933. He has been works manager since 1948.

Gustin-Bacon Adds Distributor For Three Glass Fibrous Products

Kelley Asbestos Products Company has been named exclusive Kansas City, Mo., distributors of Gustin-Bacon Manufacturing Company's Ultralite, a thermal and acoustical insulation widely used throughout the industry. Kelley will also distribute Ultrafine, a blanket type thermal and acoustical insulation, and Ultrafine Pipe Insulation, Gustin-Bacon's new one-piece pipe insulation molded of glass fibers.

Carbide and Carbon Makes Crist Physical Processes Research Head

Appointment of Dr. R. H. Crist as director of research, Physical Processes department, has been announced by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation.

Crist joined the Carbide organization in 1945 after having worked five years on the Manhattan Project. In 1946 he was assigned to the Physical Processes department at Carbide's South Charleston, W. Va., plant. He is the author of numerous papers in the field of photochemistry and reaction kinetics.

Consolidated Engineering Names Colvin, Smallman and Pollock

Promotion of three key executives of Consolidated Engineering Corporation by the company's board of directors has been announced.

Hugh F. Colvin was elevated to vice president and general manager of the corporation; Robert L. Smallman to vice president in charge of sales, and Victor Pollock to treasurer.

Colvin joined the electronic instrument firm in 1947 as treasurer and assistant to the president. He was elected vice president and treasurer in January, 1953.

Smallman, formerly director of sales for Consolidated's Electro-mechanical Instrument division, joined the firm in 1947, going there from General Electric Corporation.

Pollock joined Consolidated in May, 1952, as assistant to the treasurer following an 11-year association with W. R. Grace & Company. He was promoted to controller of Consolidated in November, 1952.

Spring Packing Elects Merriam

Charles J. Merriam, a partner in the law firm of Schroeder, Merriam, Hofgren and Brady since 1937, has been elected a director of Spring Packing Corporation, Chicago.

PETROLEUM REFINER Classified Ads

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■ FOREMAN WANTED. Man with refinery construction and maintenance experience for permanent location with independent refiner. Write giving complete record and salary desired. Box 163-R, c/o Petroleum Refiner, Houston, Texas.

■ Wanted for employment in Mexico—chemist experienced in water control of boilers and Cochrane hot process softeners. Preference given to those with experience of Frasch type sulphur recovery plants. Reply to: Mexican Sulphur Company, S.A., Jose Maria Marroqui No. 1, Mexico, D.F.

■ FIELD ENGINEER. Mechanical or Chemical, with refinery experience to provide technical field service on installation and operation of furnaces and combustion equipment in the refining and chemical industries. Knowledge of instrumentation helpful. Must be personable and willing to travel. Please send complete resume giving age, education, experience, and salary history. Excellent opportunity for advancement. All replies strictly confidential. Petro-Chem Development Company, Incorporated, 122 East 42nd St., N. Y. 17, N. Y.

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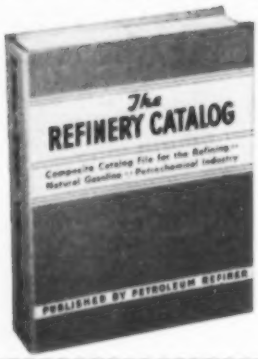
Gordon Succeeds Beattie as Inco Vice President, General Manager

J. Roy Gordon has been elected vice president and general manager of Canadian Operations of The International Nickel Company of Canada, Ltd., succeeding the late R. Leslie Beattie in both capacities.

Gordon has been an assistant vice president since December, 1947, and, since May, 1952, assistant general manager of the company's Canadian Operations under Beattie. Gordon joined Inco in 1936, when he was appointed director of the Research department. He was made an assistant to the vice president in 1941 and technical assistant to the vice president in 1946.

Advertisers in the August Issue



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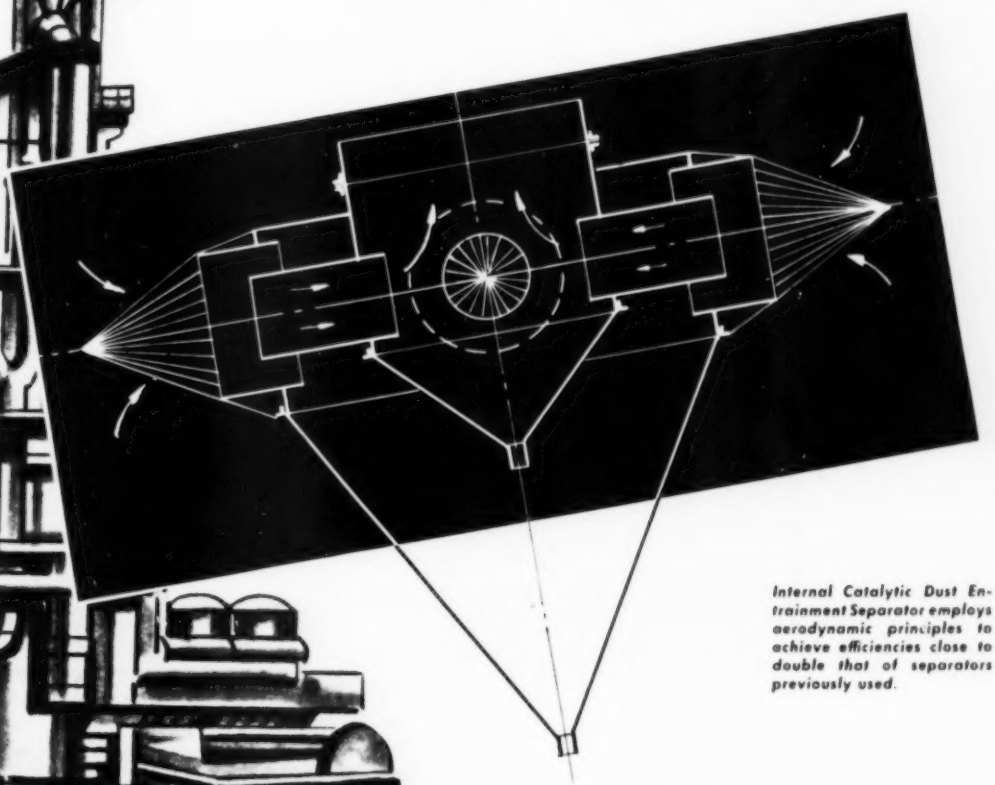

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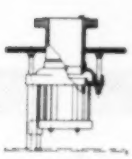

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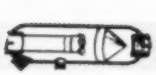

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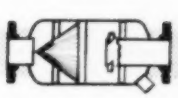

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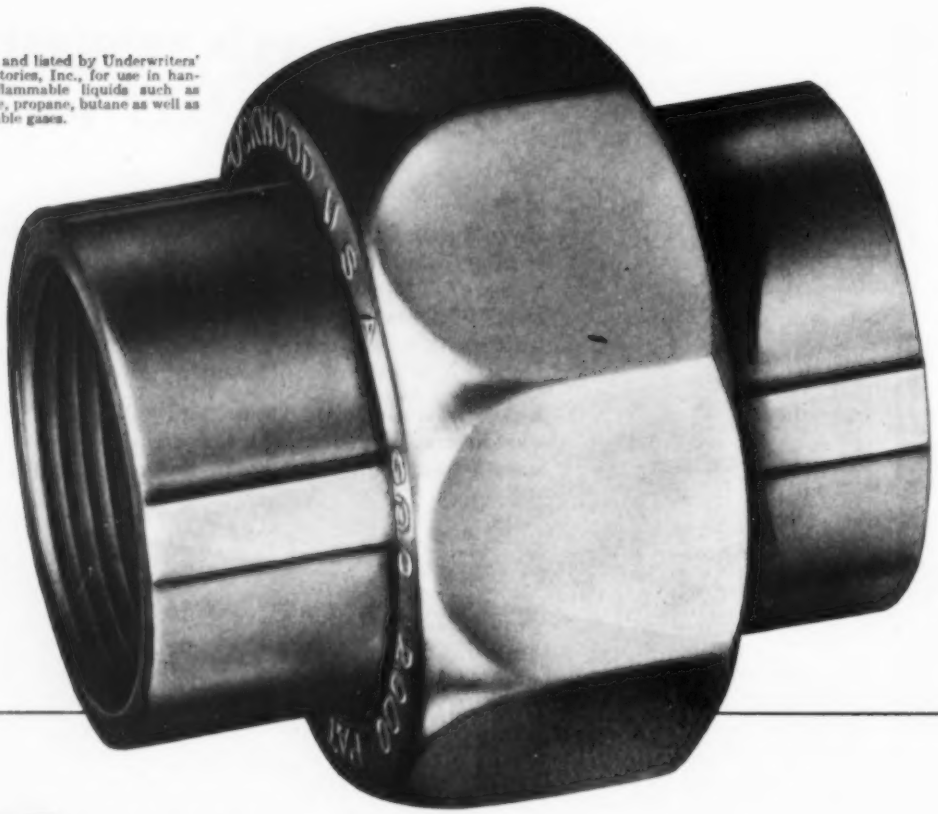

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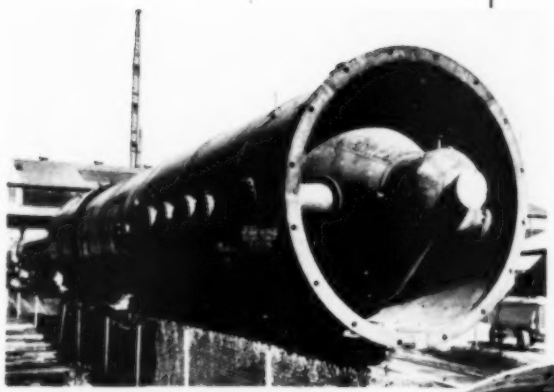

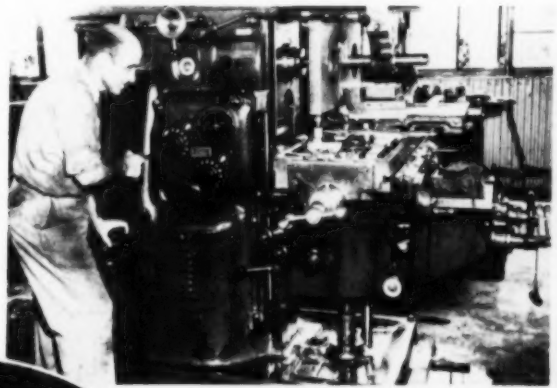

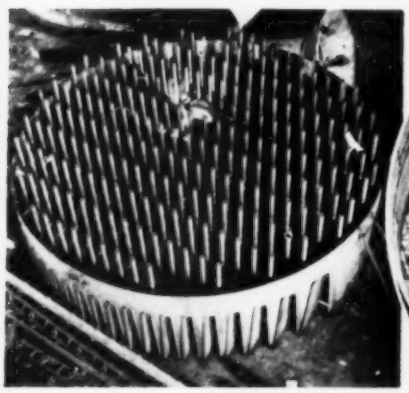

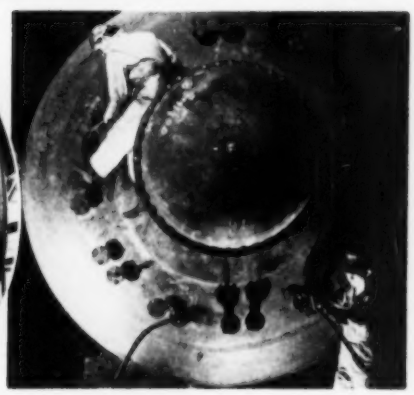

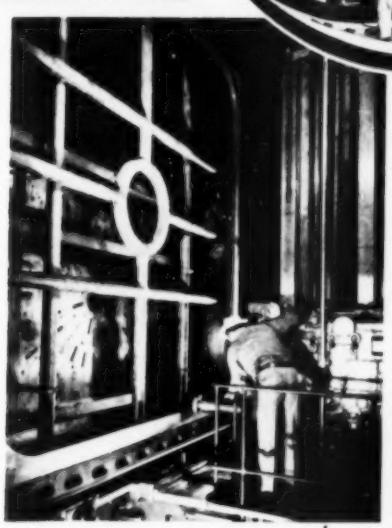

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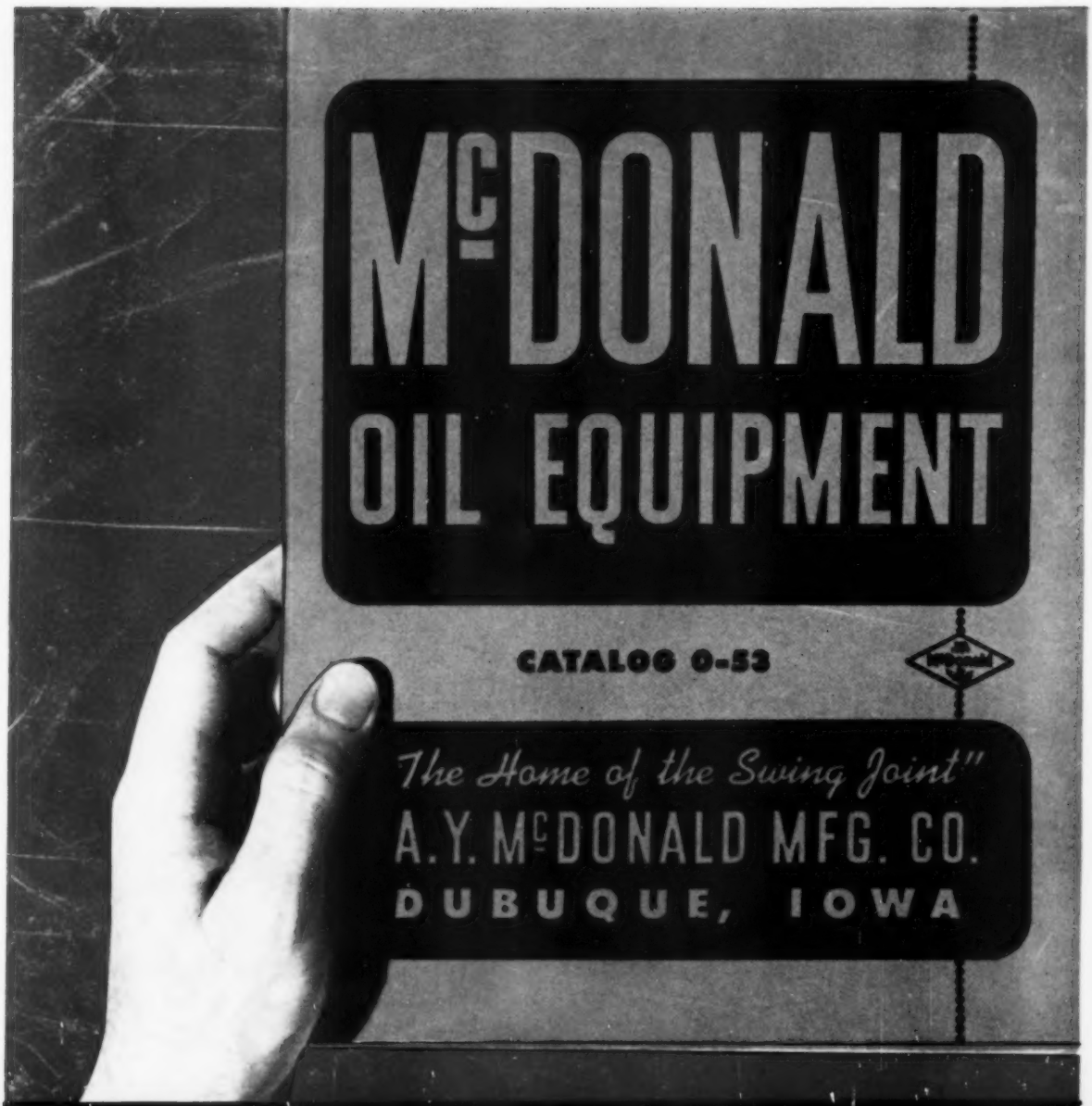

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